INSTRUCTION MANUAL

AC-DC VOLTMETER
MOD. 1002
also See Honeywell 1002

080301

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PRECISION AC-DC VOLTMETER

MODEL 1002

Serial 789

10-2

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PRECISION Standards CORP.
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Model SS-1002

The Model SS-1002 is identical to the Model 1002 except for the following specifications:

DC Accuracy

23°C ± 1°C, 90 day Calibration Cycle
± 10 PPM of reading ± 1PPM of range
± 5uV from 0 to 11 volts
±(15PPM of reading ± 1PPM of range) above 11 volts

23°C ± 3°C, 1 year Calibration Cycle
± 25PPM of reading ± 1PPM of range
± 5uV

15°C to 35°C, 1 Year Calibration Cycle

± 50PPM of reading ± 2PPM of range
± 5uV

Instrument Stability

± 3PPM of reading/day or .3PPM of Full Scale/day

7PPM of reading/month or 1PPM of Full Scale/month

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SECTION I

DESCRIPTION

1.1 INTRODUCTION

The Model 1002 Differential Voltmeter measures DC voltages up to 1100 volts in four ranges, AC voltages up to 1100 volts RMS in four ranges, and DC/DC ratios using external reference voltages up to 100 volts. AC voltages are accurately measured over the frequency range of 20 Hz to 20 KHz. This differential-input instrument is designed to provide accurate measurements with high resolution in the presence of common mode voltages. All circuits are solid state and the voltmeter contains no mechanical choppers.

1.2 FUNCTION

The voltmeter measures DC voltages by comparing the unknown voltage with a known voltage that is selected by a precision voltage divider from an internal reference supply. The measured voltage is read directly from the dials of the decade switches that operate the voltage divider. During AC measurements, the unknown AC input is converted to DC by an average-responding AC converter and the resultant DC voltage is compared with the known reference as in DC measurements. The AC converter is calibrated in the RMS value of a sine wave. During ratio measurements, the internal reference is replaced by an external reference voltage. The voltmeter can also be used as a DC standard or as a voltage divider.

1.3 EQUIPMENT DESCRIPTION

The Model 1002 Differential Voltmeter is a lightweight portable instrument designed for bench operation. Standard rack models are available on order. The meter cover and bottom panel can be removed easily to expose the internal circuits for calibration and maintenance.

1.3.1 Front Panel Controls and Features

POWER switch S4 is a two-position toggle switch, with ON and OFF positions, that control AC power to the instrument. One of the decimal point lamps is illuminated when AC power is ON.

REFERENCE switch S3 is a three-position rotary switch that selects the correct polarity of the internal reference voltage for AC and DC measurements and selects the external reference for ratio measurements. AC/POS and NEG positions permit DC null measurements of either polarity without reversing input terminals.

S3 is always set to AC/POS during AC voltage measurements. EXT position conditions the voltmeter to accept an external reference in place of the internal reference. During ratio measurements, the signal and reference inputs must agree in polarity.

Five terminal posts, HI, LO, GND, REF HI and REF LO, accept the signal and reference inputs. The GND terminal is permanently connected to chassis ground and is not used for floating measurements.

The readout consists of four lamps that set the decimal point and six dials that display the measured values. The dial readings and an internal Kelvin-Varley Divider (KVD) are controlled by six rotary switches. The switches are designated from left to right, as S5 through S10. S5 and S10 have eleven positions (0 through 10); the remaining switches have ten positions (0 through 9).

RANGE switch S2 is an eight-position rotary switch that selects full scale ranges of 1, 10, 100 and 1000 volts for DC measurements and full scale ranges of 1, 10, 100 and 1000 volts RMS for AC measurements. The voltmeter is capable of accurately measuring voltages exceeding each range (AC and DC) by 10%.

NULL switch S1 is a ten-position rotary switch that controls instrument sensitivity. When set to TVM (transistorized voltmeter) position, the full scale sensitivity of the panel meter is determined by the position of the RANGE switch. When the RANGE switch is set to DC VOLTS 1 or 10, or AC VOLTS 10, the remaining positions of the NULL switch, 10V, 1.0V, 10MV, 1.0MV, 100μV and 10μV, select the full scale sensitivity of the panel meter as indicated. When the RANGE switch is set to AC VOLTS 100 or DC VOLTS 100, the panel meter range (referred to input) is multiplied by a factor of 10 (X10 ON 100 VOLT RANGE) in all NULL positions except TVM. When the RANGE switch is set to AC VOLTS 1000 or DC VOLTS 1000, the panel meter range (referred to input) is multiplied by a factor of 100 (X100 ON 1000 VOLT RANGE) in all NULL positions except TVM. When the RANGE switch is set to AC VOLTS 1, the panel meter range (referred to input) is multiplied by a factor of 0.1 (X.1 ON 1 VOLT AC RANGE) in all NULL positions except TVM. SHORT ZERO and OPEN ZERO positions allow the voltmeter to be zeroed without disturbing inputs at the front panel terminal posts.

Panel meter M1 provides a null indication when a known voltage, selected by the Kelvin-Varley Divider, is equal to the unknown input voltage. Full scale sensitivity of the panel meter is set by the NULL switch.

SHORT CKT ZERO control R12 is used to zero the panel meter when the NULL switch is set to SHORT ZERO.

OPEN CKT ZERO control R15 is used to zero the panel meter when the NULL switch is set to OPEN ZERO.

1.3.2 Rear Panel Features

There are eight jacks, a power fuse and a line cord bracket mounted on the rear panel, and the three-wire AC line cord is passed through the rear panel (see Figure 1.1). On models connected for 115 volts AC operation, a 1/4 amp slo-blo fuse is required and on models connected for 230 volts AC operation, a 1/8 amp slo-blo fuse is required.

Jacks J5 through J10 are physically arranged to accept the optional Recorder Buffer plug-in unit (paragraph 1.4). J5 provides connection between chassis ground and the case of the plug-in unit. J6 and J7 supply +12 volts and -12 volts from the amplifier power supply, respectively. These voltages drive the modulator in the Recorder Buffer. J8 is connected to power supply ground, J9 is connected to the DC output of the amplifier (GPA-2), and J10 is connected to amplifier common.

Jacks J11 and J12 allow the Kelvin-Varley Divider to be used as an accurate voltage divider or as a DC standard (paragraphs 2.5.5 and 2.5.6). J11 is connected to the arm of S10 (output of the KVD) and J12 is connected to reference common.

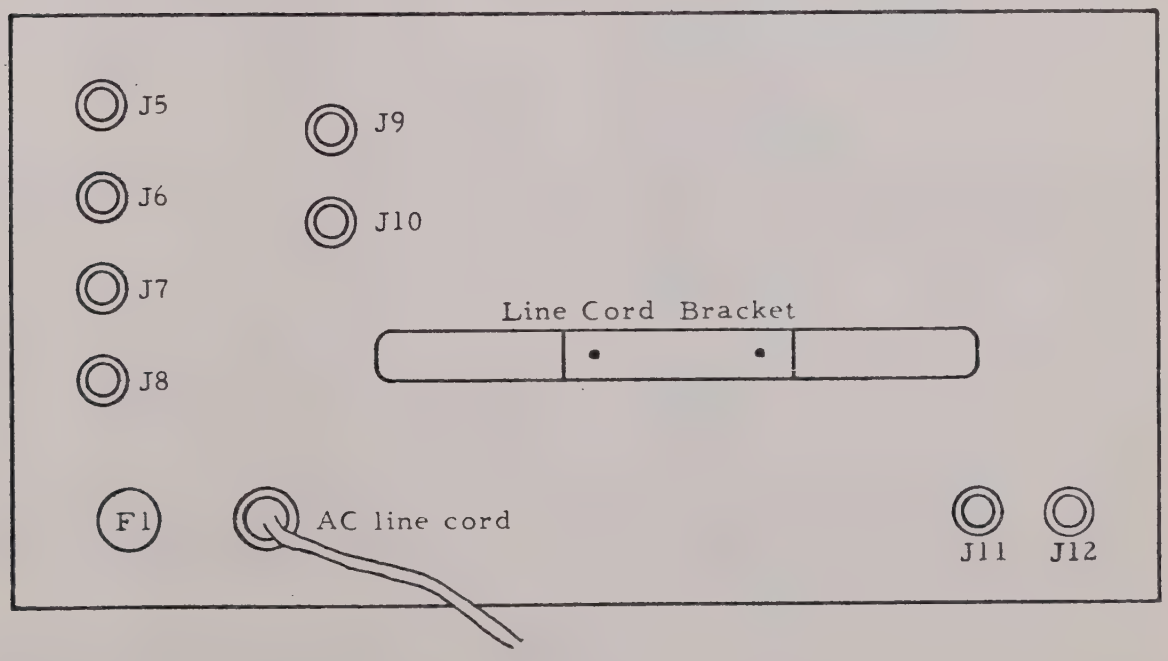


Figure 1.1. Rear Panel Features

1.4 RECORDER BUFFER OPTION

The Recorder Buffer is an optional plug-in unit that allows a recording device to follow variations of the DC output from the internal amplifier, and thus, variations of the unknown input. The buffer unit modulates the amplifier output, couples it across an isolation transformer, and demodulates the resultant signal to provide a DC voltage to the recorder that is proportional to the amplifier output. A variable control sets the maximum level of the buffer's full scale output. Operating power for the buffer is derived from the voltmeter.

1.5 SPECIFICATIONS

1.5.1 Universal Specifications

These specifications apply for all operating modes, unless otherwise noted here or in paragraphs 1.5.2, 1.5.3, 1.5.4, 1.5.5 and 1.5.6.

Operating Conditions:

Reference conditions:	23°C ±1°C, relative humidity less than 70%, AC line 112 to 118 volts 30 day calibration cycle.
Rated conditions:	15°C to 35°C, relative humidity less than 70%, AC line 105 to 125 volts, 60 day calibration cycle. Reduce rated-condition accuracies (non-linearity) of paragraphs 1.5.2 and 1.5.3 ± 0.001% of reading per degree centigrade from 5°C to 15°C and from 35°C to 45°C.
Warmup Time:	2 minutes to rated-condition accuracy. 30 minutes to reference-condition accuracy.
Maximum Common Mode Voltage:	500 volts DC or peak AC.
Power Requirements:	115±10 volts AC or 230±20 volts AC, 50 to 440 Hz; less than 15 volt-amperes at 115 volts, 60 Hz.

1.5.2 DC Differential Voltmeter Specifications

Input Ranges:	±1 volt, ±10 volts, ±100 volts, and ±1000 volts with 10% over-ranging on all ranges.

Accuracy:	±5μV ±0.0001% of full scale ±0.0025% of reading at stated reference conditions (paragraph 1.5.1).
	±5μV ±0.0002% of full scale ±0.005% of reading at stated rated conditions (paragraph 1.5.1).
Stability:	For constant operating conditions and exclusive of zero drift: ±5 PPM per day, ±15 PPM per month, or ±0.5 PPM of full scale, whichever is greater.
DC Common Mode Rejection: (Zero impedance source)	120 db on 1 and 10 volt ranges; ±0.1 PPM of full scale per volt common mode on 100 and 1000 volt ranges.
60 Hz Common Mode Rejection:	Carrier frequency of null detector is much higher than, and asynchronous with 60 Hz. The only effect of 60 Hz common mode is an increase in noise level until conditions result in amplifier saturation and instability.
Input Resistance:	
1 and 10 volt ranges:	Potentiometric to 11 volts.
100 volt range:	11 megohms to 110 volts.
1000 volt range:	10 megohms to 1100 volts.
Voltage Dial Resolution:	±0.0001% of full scale reading from six decade switches or ±1μV.
Internal Reference:	±11 volts, Zener regulated supply.
Reference polarity:	Reversible at front panel REFERENCE switch which also selects external reference (EXT) for ratio measurements.

Line regulation: ±10% AC line change causes not more than ±0.0002% internal reference change.

Panel Meter Sensitivity: Full scale sensitivity, referred to input (RTI), is governed by positions of NULL and RANGE switches (see Table 1.1).

Panel Meter Accuracy:

1, 10 and 1000 volt ranges: ±5% of full scale for all positions of NULL switch, except TVM.

100 volt range: ±13% of full scale for all positions of NULL switch except TVM.

All ranges: ±3% of full scale with NULL switch set at TVM.

Table 1.1. Panel Meter Sensitivity

NULL Position	10V	1.0V	0.1V	10MV	1.0MV	100μV	10μV
RANGE Position	FULL SCALE SENSITIVITY (RTI)						
DC 1	10V	1.0V	0.1V	10MV	1.0MV	100μV	10μV
AC 1	1V	0.1V	10MV	1.0MV	*100μV	*10μV	*1μV
AC & DC10	10V	1.0V	0.1V	10MV	1.0MV	*100μV	*10μV
AC & DC 100	100V	10V	1V	0.1V	10MV	1MV	*100μV
AC & DC 1000	1000V	100V	10V	1V	0.1V	10MV	1MV

* During AC measurements, normal input noise causes the panel meter to be unstable.

1.5.3 DC/DC Ratiometer Specifications

Ratio Ranges: Signal Input:External Reference

10 volt input range: From 0:1 to 1:1 (overranging not usable).

100 volt input range: From 0:1 to 10:1 (overranging not usable).

1000 volt input range: From 0:1 to 100:1 (overranging not usable).

Accuracy:	±5μV ±0.0002% of full scale ±0.001% of reading at stated reference conditions (paragraph 1.5.1).
	±5μV ±0.0003% of full scale ±0.0025% of reading at stated rated conditions (paragraph 1.5.1).
Kelvin-Varley Divider:	
Dial Resolution:	Same as paragraph 1.5.2.
Linearity:	±0.0002% of full scale ±0.001% of reading at stated reference conditions (paragraph 1.5.1).
	±0.0003% of full scale ±0.002% of reading at stated rated conditions (paragraph 1.5.1).
Output resistance:	30 kilohms maximum at rear panel connectors J11 and J12.
External Reference:	
Voltage:	Up to ±100 volts maximum, must have same polarity as signal input.
Input resistance:	20 kilohms.

1.5.4 Indicating DC Voltmeter Specifications

These specifications apply to DC voltage readings taken directly from the panel meter.

TVM Mode:	NULL switch set to TVM, and ranges selected by RANGE switch.
Accuracy:	±3% of full scale.
Ranges:	1, 10, 100 and 1000 DC VOLTS plus 10% overranging on all ranges.
Input resistance:	10 megohms on all ranges.
*Extended TVM Mode:	RANGE switch set to DC VOLTS 1 or 10, and ranges selected by NULL switch.

Accuracy:	±5% of full scale.
Ranges:	0.1V, 10MV, 1MV, 100μV and 10μV plus 10% overrange on all ranges.
Input resistance:	10 megohms on all ranges.

*All decade switch dials must be set to zero, and the REFERENCE switch set to AC/POS or NEG. (REFERENCE may be set to EXT with no apprecialbe error, if the external reference voltage does not exceed 15 volts.)

1.5.5 AC Differential Voltmeter Specifications

Input Ranges:	1 volt, 10 volts, 100 volts and 1000 volts rms with 10% overranging on all ranges.
Frequency Range:	20 Hz to 20 KHz specified, usable to 5 Hz with reduced performance.
Accuracy:	
Reference conditions: (paragraph 1.5.1)	50 Hz to 5 KHz:±0.005% of full scale ±0.05% of reading. 30 Hz to 10 KHz:±0.01% of full scale ±0.05% of reading. 20 Hz to 20 KHz:±0.03% of full scale ±0.08% of reading.
Rated conditions: (paragraph 1.5.1)	50 Hz to 5 KHz:±0.01% of full scale ±0.15% of reading. 30 Hz to 10 KHz:±0.02% of full scale ±0.15% of reading. 20 Hz to 20 KHz: ±0.03% of full scale ±0.2% of reading.
Input Impedance:	
1, 10 and 100 volt ranges:	1 megohm shunted by 125 pf max.
1000 volt range:	2 megohms shunted by 100 pf max.
Voltage Dial Resolution:	Same as paragraph 1.5.2.
Internal Reference:	+11 volts, Zener regulated supply (REFERENCE switch must be set to AC/POS).
Panel Meter Sensitivity:	Full scale sensitivity, referred to input (RTI), is governed by positions of NULL and RANGE switches (see Table 1.1).

Panel Meter Accuracy:	
All ranges:	±3% of full scale in all NULL positions.
DC Blocking Voltage:	350 volts. Capacitor follows attenuator in 10, 100, and 1000 volt ranges.
DC Common Mode Rejection:	±0.2 PPM of full scale per volt common mode.
60 Hz Common Mode Rejection: (zero source impedance)	2 PPM of full scale per volt common mode.

1.5.6 Indicating AC voltmeter Specifications

These specifications apply to AC voltage readings taken directly from the panel meter with the NULL switch set to TVM.

Accuracy:	±3% of full scale.
Ranges:	1, 10, 100 and 1000 AC VOLTS plus 10% overranging on all ranges.
Input Impedance:	Same as paragraph 1.5.5.
DC Blocking Voltage:	Same as paragraph 1.5.5.
DC Common Mode Rejection:	Same as paragraph 1.5.5.
60Hz Common Mode Rejection: (zero source impedance)	Same as paragraph 1.5.5.

SECTION II

OPERATION

2.1 INSPECTION

After unpacking, inspect the equipment. If shipping damage is found, report the facts to the shipping agency and to Honeywell. If equipment fails to operate as specified, check all connectors, cables and fuse. Should equipment fail to operate satisfactorily during the warranty period, follow the procedure outlined in the warranty.

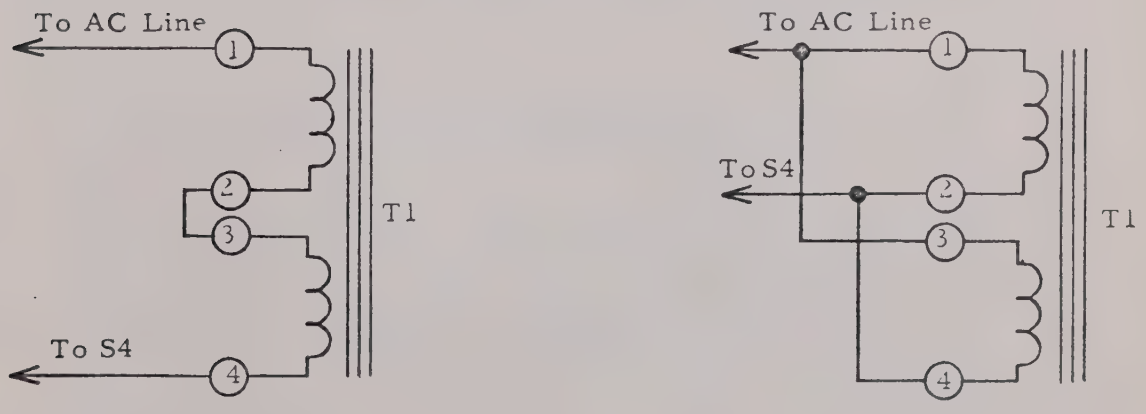
2.2 PRIMARY AC POWER

Unless requested otherwise, this instrument is supplied wired for 115 volts AC operation. Should operation at 230 volts AC be required, remove the bottom panel and reconnect primary supply jumpers as shown in Figure 2.1. and install a 1/8 amp slo-blo fuse in the fuse receptacle.

2.3 PRECAUTIONS

a. The floating input should not exceed 500 volts above or below chassis ground.

b. The maximum overload permissible with the NULL switch in the 10μV position is 100 volts (applies to DC 1 and 10 volt ranges only).



(a) 230 volt AC operation, use 1/4 amp fuse.

(b) 115 volt AC operation, use 1/2 amp fuse.

Figure 2.1. Power Transformer Wiring

2.4 ZERO ADJUSTMENTS

2.4.1 Mechanical Zero

With the POWER switch set to OFF and with J9 and J10 on the rear panel shorted together, check the mechanical zero of the panel meter. If necessary, adjust to zero by means of the screw located near the pivot of the pointer. Remove the short.

2.4.2 Electrical Zero

a. Set the POWER switch to ON and allow a minimum warmup of 30 minutes to obtain maximum accuracy.

b. Set the NULL switch to SHORT ZERO and adjust the SHORT CKT ZERO control until the panel meter reads zero.

c. Set the NULL switch to OPEN ZERO and adjust the OPEN CKT ZERO control until the panel meter reads zero.

NOTES

(1) Positions of all other switches do not affect the zero adjustments.
(2) The voltmeter may be zeroed at anytime without removing the input signals.

2.5 OPERATING PROCEDURES

For most applications, the procedures outlined in the paragraphs that follow will provide adequate measurement results. However, the voltmeter is extremely sensitive and the recommendations in paragraph 2.6 should be followed for special applications.

2.5.1 DC Voltage Measurements

a. Zero the voltmeter according to paragraph 2.4.2 and set the REFERENCE switch to AC/POS or NEG.

b. Set the NULL switch to TVM and set the RANGE switch to the DC VOLTS position that affords the maximum resolution for the voltage to be measured. This occurs when the first decade of the readout is a significant figure in the reading. For example: if a voltage to be measured is known to be approximately 90 volts, the 100-volt range should be selected. If the approximate value is not known, set the RANGE switch to DC VOLTS 1000.

c. For floating measurements the unknown DC input is connected to the HI and LO terminals as shown in Figure 2.2 and the GND terminal is not used. During non-floating measurements,

the GND terminal should be connected to the LO terminal.

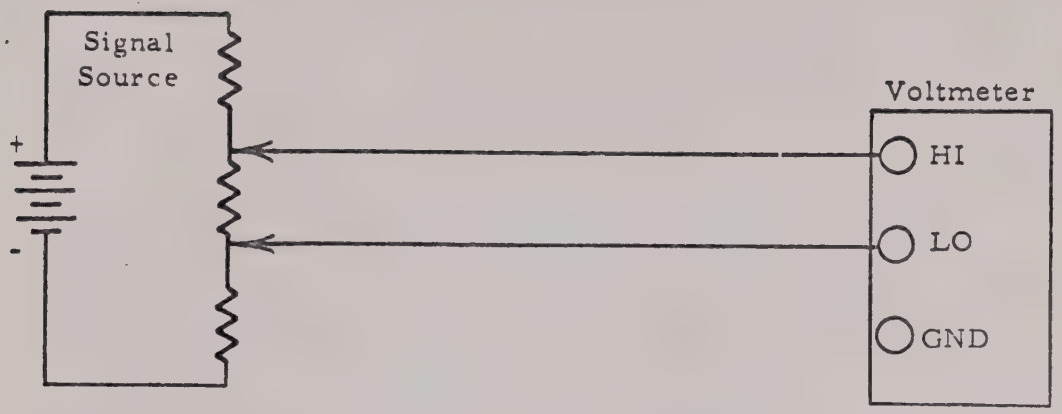


Figure 2.2. Connections for Floating DC Measurements

d. The voltage now indicated on the panel meter is accurate to within ±3%. A deflection to the right indicates that the unknown input is positive and a deflection to the left indicates that the unknown input is negative. Move the RANGE switch to a lower DC range if the pointer deflection is less than 1/11th of full scale.

NOTE

When the NULL switch is advanced from the TVM position, the meter deflection may reverse due to the position of the REFERENCE switch.

e. Set the first two decade switches (S5 and S6) to the approximate TVM reading. Advance the NULL switch to the 10V position. Continue to adjust the decade switches (S5 through S10) to obtain a null on the panel meter while increasing the voltmeter sensitivity by moving the NULL switch clockwise.

NOTE

Because the voltmeter sensitivity is higher than the stability of many voltage sources, a zero reading may not be possible if the unknown source is fluctuating.

2.5.2 AC Voltage Measurements

a. Zero the voltmeter according to paragraph 2.4.2 and set the REFERENCE switch to AC/POS.

b. Set the NULL switch to TVM and set the RANGE switch to the AC VOLTS position that affords the maximum resolution for the voltage to be measured. (Refer to paragraph 2.5.1b). If the approximate value is not known, set the RANGE switch to AC VOLTS 1000.

c. For floating measurements the unknown AC input is connected to the HI and LO terminals as shown in Figure 2.3 and the GND terminal is not used. During non-floating measurements, the GND terminal should be connected to the LO terminal.

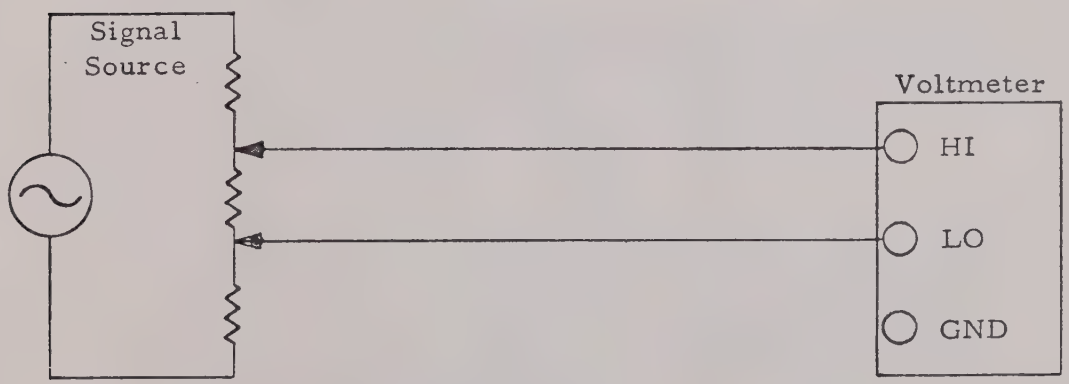


Figure 2.3. Connections for Floating AC Measurements

d. The voltage now indicated on the panel meter is accurate to within ±3%. Move the RANGE switch to a lower AC range if the pointer deflection is less than 1/11th of full scale.

e. Set the first two decade switches (S5 and S6) to the approximate TVM reading. Advance the NULL switch to the 10V position. Continue to adjust the decade switches (S5 through S10) to obtain a null on the rear panel meter while increasing the voltmeter sensitivity by moving the NULL switch clockwise.

NOTE

Because the voltmeter sensitivity is higher than the stability of many voltage sources, a zero reading may not be possible if the unknown source is fluctuating. Also, normal input noise causes the panel meter to be unstable at NULL settings of 100μV or less.

2.5.3 Excursions about a Nominal Voltage

The voltmeter may be used as a direct reading monitor to read voltage excursions about a nominal value.

a. Follow the procedure outlined in paragraph 2.5.1 or 2.5.2 as applicable.

b. After a null has been achieved for the nominal value, set the NULL switch to the position which allows the expected deviation to remain on scale.

c. The deviation from the nominal may now be read directly from the panel meter scale. For example: if the NULL switch is set to 10MV, a full scale deviation (+ or -) indicates 11 millivolts differential from the readout setting.

NOTE

During DC measurements, the output resistance may reduce the value of the panel meter reading (paragraph 1.5.4). If the RANGE switch is set to DC VOLTS 100, the 100 volt range attenuator will also reduce the value of the meter reading.

2.5.4 DC/DC Ratio Measurements

During ratio measurements, the decimal point at the far left is always illuminated, therefore, the input attenuator must be considered when the displayed value is read. The ratio value is read directly only in the 10 volt range; in the other DC positions (100 and 1000) of the RANGE switch, the ratio values must be determined from Table 2.1. Position 10 of decade switch S5 is not used during ratio measurements.

Table 2.1. Determination of Ratio Values

RANGE (DC VOLTS)	VALUE DISPLAYED	ACTUAL VALUE
10V	.XXXXXX	.XXXXXX
100V	.XXXXXX	X.XXXXX
1000V	.XXXXXX	XX.XXXX

Proceed with ratio measurements as follows:

a. Initially condition and zero the voltmeter according to paragraph 2.4.2.

b. Set the NULL switch to TVM, the REFERENCE switch to EXT, and the RANGE switch to the DC VOLTS position desired (position 10 provides direct readings).

c. Connect the signal and external reference inputs to the HI, LO, REF HI and REF LO terminals as shown in Figure 2.4. (The signal and external reference voltages must agree in polairty). For floating measurements, the GND terminal is not used. During non-floating measurements, the GND terminal should be connected to the LO terminal.

NOTE

The external reference should not exceed 100 volts.

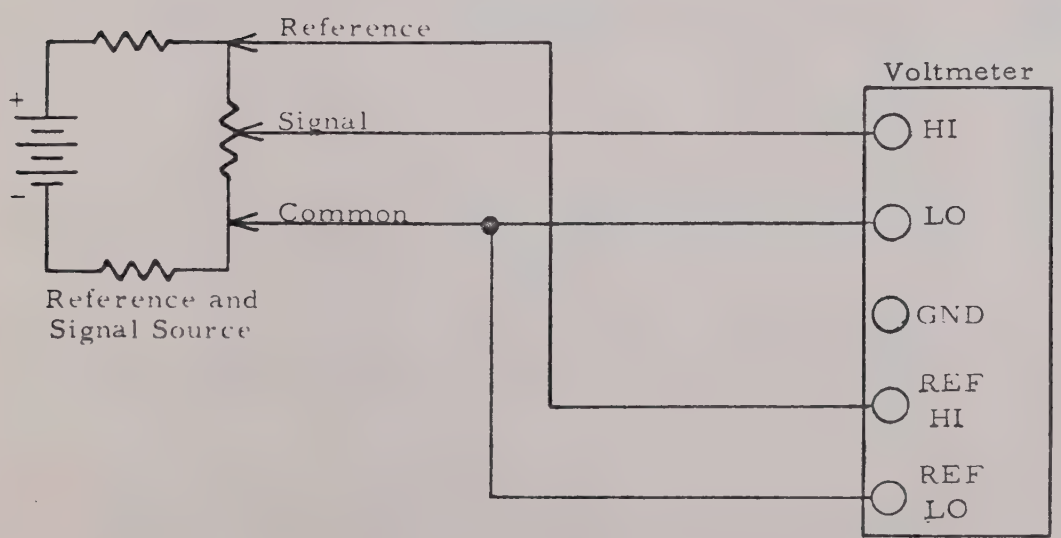


Figure 2.4. Connections for Floating DC/DC Ratio Measurements

d. With the NULL switch set to TVM, the panel meter displays the approximate value (±3%) of the signal input. Consider this value and the value of the external reference to make the initial settings of decade switches S5 and S6.

e. Advance the NULL switch to the 10V position. Continue to adjust the decade switches (S5 through S10) to obtain a null on the panel meter while increasing the voltmeter sensitivity by moving the NULL switch clockwise.

2.5.5 Recorder Operation

Two methods are used to allow a recording device to follow output variations of the internal amplifier (GPA-2). In one method, the Recorder Buffer (paragraph 1.4) is plugged into rear terminals J5 through J10 and the recording instrument is connected to the two output jacks on the Recorder Buffer.

In a second method, the recording device is connected directly to the output of the internal amplifier through rear panel jacks J9 and J10 as shown in Figure 2.5. The leakage resistance between the recorder terminals and ground (LO terminal of voltmeter) should be 5×10^{11} ohms or greater. The recorder must be guarded and isolated from the AC line. Any loading of the output terminals (between ground and either J9 or J10) will cause measurement errors at the voltmeter. To prevent loading of the voltmeter, the input resistance of the recorder should be at least 2 kilohms. The full scale output at J9 and J10 is 1 volt and the output resistance is approximately 1 ohm.

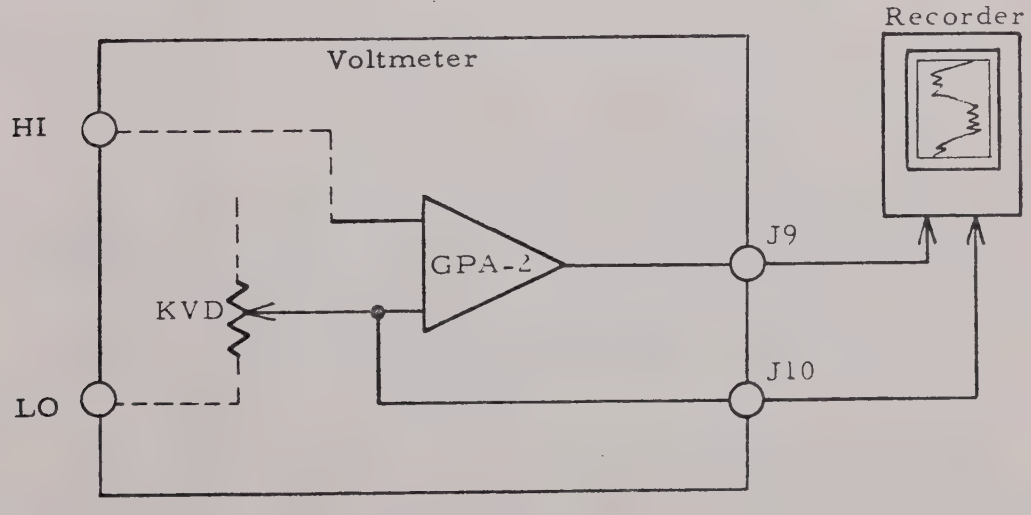


Figure 2.5. Typical Recorder Connections

2.5.6 Using the Voltmeter as a DC Voltage Divider

a. Set the NULL switch to TVM, the REFERENCE switch to EXT, and the POWER switch to OFF or ON.

b. Set the RANGE switch to DC VOLTS 1 or 10. In the 1 volt range, the reference input attenuator divides the external voltage by a factor of 10 before it reaches the Kelvin-Varley Divider. In the 10 volt range, the external voltage reaches the Kelvin-Varley Divider without attenuation. Position 10 of decade switch S5 is not used when the RANGE switch is set to DC VOLTS 10.

c. Connect the external voltage to the REF HI and REF LO terminals as shown in Figure 2.6. The KVD output is taken at rear panel jacks J11 and J12. The external voltage should not exceed 100 volts DC.

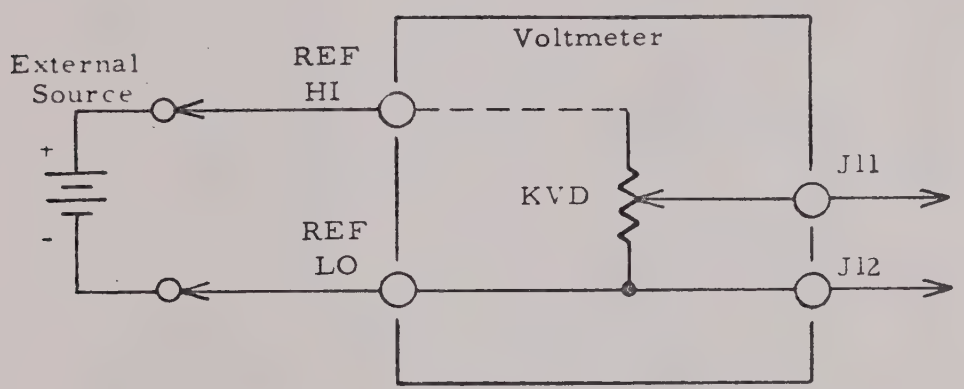


Figure 2.6. Voltmeter Connected as a Voltage Divider

d. Set the decade switches (S5 through S10) to obtain the desired voltage output at J11 and J12. For example: with the RANGE switch set to DC VOLTS 1, an external voltage input of -100 volts, and an output at J11 and J12 of -5.34761 volts is desired, set the decade switches to display 534761 in the readout.

2.5.7 Using the Voltmeter as a DC Standard

The voltmeter may be used as a DC standard to calibrate the lower ranges of other test instruments, e.g., automatic digital voltmeters. The test instruments must have a high input impedance, 1000 megohms or greater. Proceed as follows:

a. Disconnect all leads and shorts from the HI, LO, REF HI, REF LO and GND terminals on the front panel.

b. Set the NULL switch to TVM, the RANGE switch to DC VOLTS 1 or 10, and the REFERENCE switch to AC/POS if a positive reference voltage is required or to NEG if a negative reference is required. When the RANGE switch is set to DC VOLTS 1, a 1.1 volt reference is supplied to the Kelvin-Varley Divider and when the RANGE switch is set to DC VOLTS 10, an 11 volt reference is supplied to the Kelvin-Varley Divider. All positions of decade switch S5 are useable in this operation, including position 10 to check overranging of the test instrument.

c. Connect the input leads of the instrument to be calibrated to J11 and J12 on the rear panel of the voltmeter as shown in Figure 2.7.

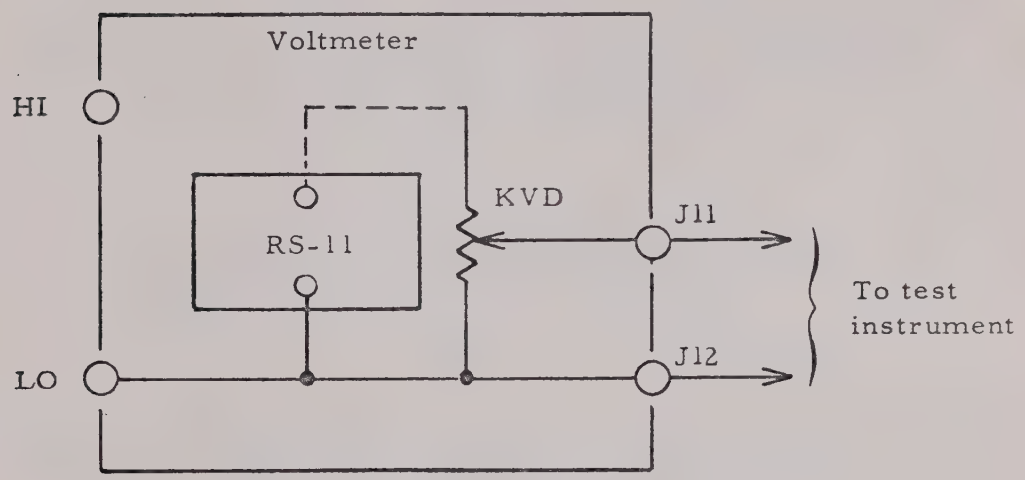


Figure 2.7. Voltmeter Connected as a DC Standard

d. Set the decade switches (S5 through S10) to obtain the desired voltage output at J11 and J12. Examples: if the desired output is +9.5550 volts, set the RANGE switch to DC VOLTS 10, set the REFERENCE switch to AC/POS and set the decade switches to display 9.55500; or if the desired output is -1.01230, set the RANGE switch to DC VOLTS 1, set the REFERENCE switch to NEG and set the decade switches to display .(10)12300. (Position 10 of S5 is indicated by (10)).

2.5.8 Indicating DC Voltmeter

To obtain quick, approximate DC voltage readings directly from the panel meter, proceed as follows:

a. When the input voltage exceeds 0.1 volt, follow steps a. through d. in paragraph 2.5.1 to read the voltage directly from the panel meter.

NOTE

When the NULL switch is set to TVM, the decade switch positions have no effect on the panel meter reading. However, for all other positions of the NULL switch, all decade dials must be set to zero.

b. When the input voltage is less than 0.1 volt, set the RANGE switch to DC VOLTS 1 or 10 and set the NULL switch to a position (0.1V, 10MV, 1MV, 100μV or 10μV) that is compatible with the value of the input voltage. (When in doubt, select the higher NULL ranges first). The reading on the panel meter is accurate to ±5% of full scale.

NOTE

EXT position of the REFERENCE switch can cause some reduction in accuracy for readings obtained in step b., but not in step a.

2.5.9 Indicating AC Voltmeter

To obtain quick, approximate AC voltage readings directly from the panel meter, follow steps a through d in paragraph 2.5.2.

2.6 SPECIAL CONSIDERATIONS

The accuracy (approximately 0.001%), resolution (approximately 0.1 PPM full scale), and extreme sensitivity (less than 1 microvolt) of the voltmeter makes it comparable to standards laboratory equipment. To obtain full use of the voltmeter in laboratory tests:

a. Avoid touching any of the leads or clips during measurements.

b. Avoid thermal emf's due to dissimilar metals. In this respect, all input cables, ground return cables, shorting cables, and cable clips should be copper.

c. During ratio measurements, the lead resistance of current carrying wires should be considered, e.g., 10 milliohms/ft for No. 20 AWG copper wire.

SECTION III

THEORY OF OPERATION

3.1 PRINCIPLE OF OPERATION

Model 1002 operates on the principle of comparing an unknown voltage with a known voltage that is selected by a Kelvin-Varley Divider from a reference voltage source. The voltmeter, illustrated in block form by Figure 3.1., has two modes of operation: TVM (transistorized voltmeter) and differential.

In the TVM mode (S1 set to TVM), the voltmeter operates similar to a VTVM to obtain the approximate value of the unknown input. DC inputs bypass the DC input attenuator and receive range attenuation, according to range, from the TVM attenuator. AC inputs receive range attenuation at the AC input attenuator, are applied to the AC converter, and the resultant DC is attenuated by a fixed (does not vary with range) TVM attenuator. Divided signals from the TVM attenuator are then applied to the null detector. At the input of the null detector, the full scale sensitivity is 1 millivolt, i.e., an input signal of 1 millivolt to the GPA-2 amplifier will cause a full scale deflection of the panel meter (10 major divisions, the 11th division accommodates the 10% overrange feature). The reference voltages, reference attenuator, and the Kelvin-Varley Divider are not used in the TVM mode.

In the differential mode (all other positions of S1), the voltmeter provides accurate measurements and the type of measurement depends upon the position of the REFERENCE switch. If S3 is set to AC/POS or NEG, the voltmeter is conditioned for voltage measurements, and if S3 is set to EXT, the voltmeter is conditioned for DC/DC ratio measurements. The selected reference is attenuated according to range and applied to the KVD where it is accurately divided and the resulting output is applied to the null detector. In the 1 and 10 volt DC ranges, the unknown input signal bypasses the DC input attenuator, but in the 100 and 1000 volt DC ranges, the DC input attenuators divide the unknown signal by factors of 10 and 100, respectively. The AC input attenuator provides similar division of AC inputs in the 10, 100 and 1000 volt AC ranges and passes signals in the 1 volt AC range without attenuation.

3.2 CIRCUIT DESCRIPTIONS

3.2.1 AC Input Attenuator

The AC input attenuator consists of eight fixed resistors, three

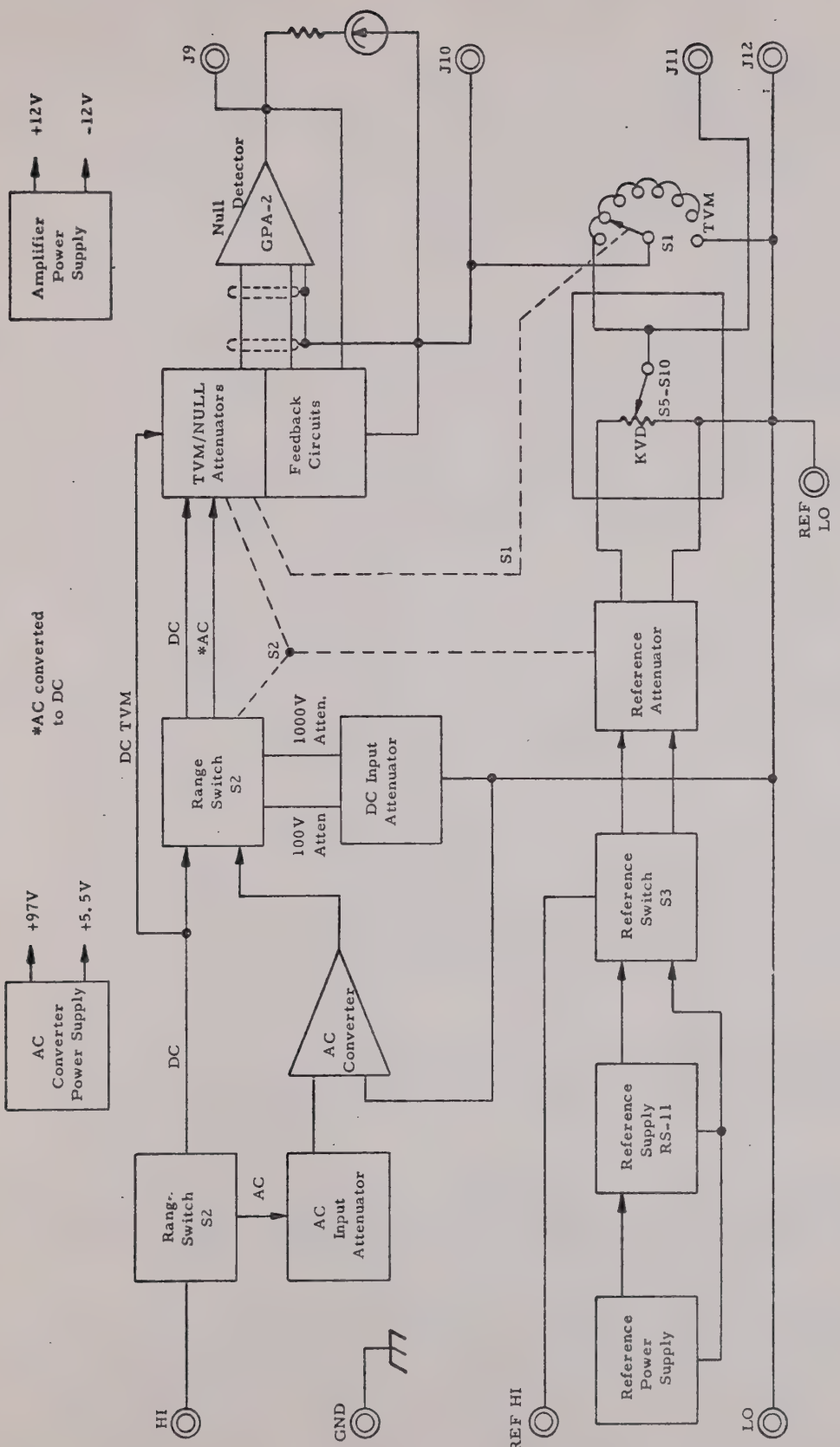


Figure 3.1. Voltmeter Block Diagram

variable resistors, seven fixed capacitors and three trim capacitors. In both modes of operation, differential and TVM, this attenuator is controlled by sections G and F of RANGE switch S2. In the 10, 100 and 1000 volt AC ranges, the attenuator divides the unknown AC input signal by factors of 10, 100 and 1000, respectively. The attenuator is bypassed in the 1 volt AC range.

3.2.2 DC Input Attenuator

The DC input attenuator consists of eight resistors, and the 100V CAL and 1000V CAL adjustments. In the differential mode, this attenuator is controlled by sections C and F of RANGE switch S2. In the 100 and 1000 volt DC ranges, the attenuator divides the unknown DC input signal by factors of 10 and 100, respectively. The attenuator is bypassed in the 1 and 10 volt DC ranges. When the voltmeter is in the TVM mode, S1 and S2 are interconnected to bypass the DC input attenuator in all ranges.

3.2.3 Reference Attenuator

The reference attenuator consists of two resistors and the 1V CAL adjustment, and is controlled by Section D of the RANGE switch. When S2 is set to DC VOLTS 1, the selected reference is divided by a factor of 10 before it reaches the KVD. The reference attenuator is not used in the AC ranges or in the three higher DC ranges.

3.2.4 TVM/NULL Attenuators

The TVM/NULL attenuators consist of ten resistors and a filter capacitor that are controlled by Section C of S1 and Sections B and C of S2. The resistors are used in various combinations in both operational modes (differential and TVM) to reduce the value of the signal input to a usable level at the input of the amplifier.

3.2.5 Feedback circuit

The feedback circuit consists of five resistors that are controlled by Section D of S1. This circuit establishes the closed loop gain of the amplifier for all NULL ranges and both operational modes.

3.2.6 Null Detector

The null detector is a potentiometric, non-inverting DC amplifier (GPA-2) that compares the attenuated signal input with the output of the Kelvin-Varley Divider, and drives the panel meter with the amplified difference between these two voltages. The KVD output is connected to amplifier common to float the amplifier at the potential selected by the KVD decade switches. When the KVD dials are set at a reading that equals the unknown signal at the input terminals,

the difference voltage approaches the threshold limit of the amplifier and the reading on the panel meter approaches zero. In the TVM mode, amplifier common is connected to signal common (LO terminal).

The amplifier, shown in block form by Figure 3.2, consists of an oscillator, electronic chopper, carrier amplifier, demodulator, post amplifier, and voltage regulators. The feedback and zero offset circuits, which are normally integral parts of an amplifier, are not mounted on the amplifier card; these circuits are outlined by broken lines in Figure 3.2. On the Model 1002, zero adjustments have been mounted on the front panel for the operator's convenience.

The oscillator is a free-running multivibrator that provides square wave outputs to drive the electronic chopper and the demodulator. The frequency of the oscillator is set much higher than, and asynchronous with 60 cps. The square wave that drives the demodulator is in phase with the square wave that controls the feedback chopper-transistor and out of phase with the square wave that controls the signal input chopper-transistor.

Field-effect transistors are used in the electronic chopper to alternately sample the signal input and the feedback voltages. A resulting square wave (difference signal) is capacitively coupled to the carrier amplifier which has a forward (open loop) gain of approximately 60 db. The carrier amplifier has three stages, therefore, its input and output signals are out of phase.

From the carrier amplifier, the amplified and inverted difference signal is capacitively coupled to the demodulator. The demodulator alternately switches between one alternation of the difference signal and amplifier common, and the resultant signal is routed to the post amplifier. At the post amplifier, the demodulated signal is filtered, amplified and inverted to produce a DC voltage proportional to the difference between the unknown input voltage and the output of the KVD.

Figure 3.3 illustrates the phase relationships between the oscillator outputs and the signal voltages throughout the amplifier. In the example given, the KVD output is set at zero volts and the input signal is positive. Turning the decade dials to obtain a more positive KVD output would cause the difference signal to become smaller and the amplifier output to approach zero.

3.2.7 Reference Supply, RS-11

The reference supply, shown in block form in Figure 3.4, consists of a differential amplifier, reference diode, voltage-setting divider and temperature-compensating bridge. The output from this supply, 11 volts, is selected by the REFERENCE switch and routed to the Kelvin-Varley Divider.

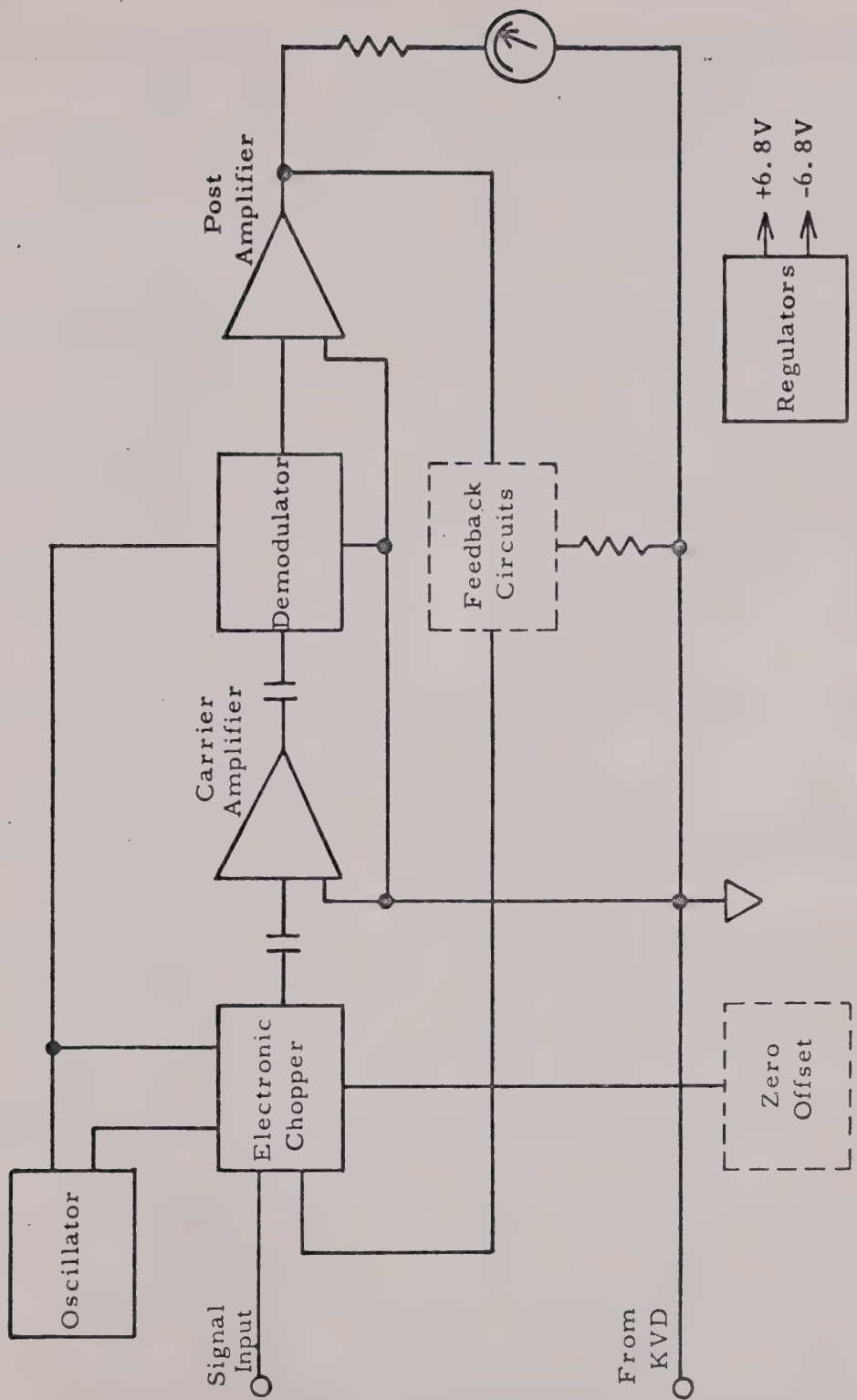


Figure 3.2. Null Detector Block Diagram

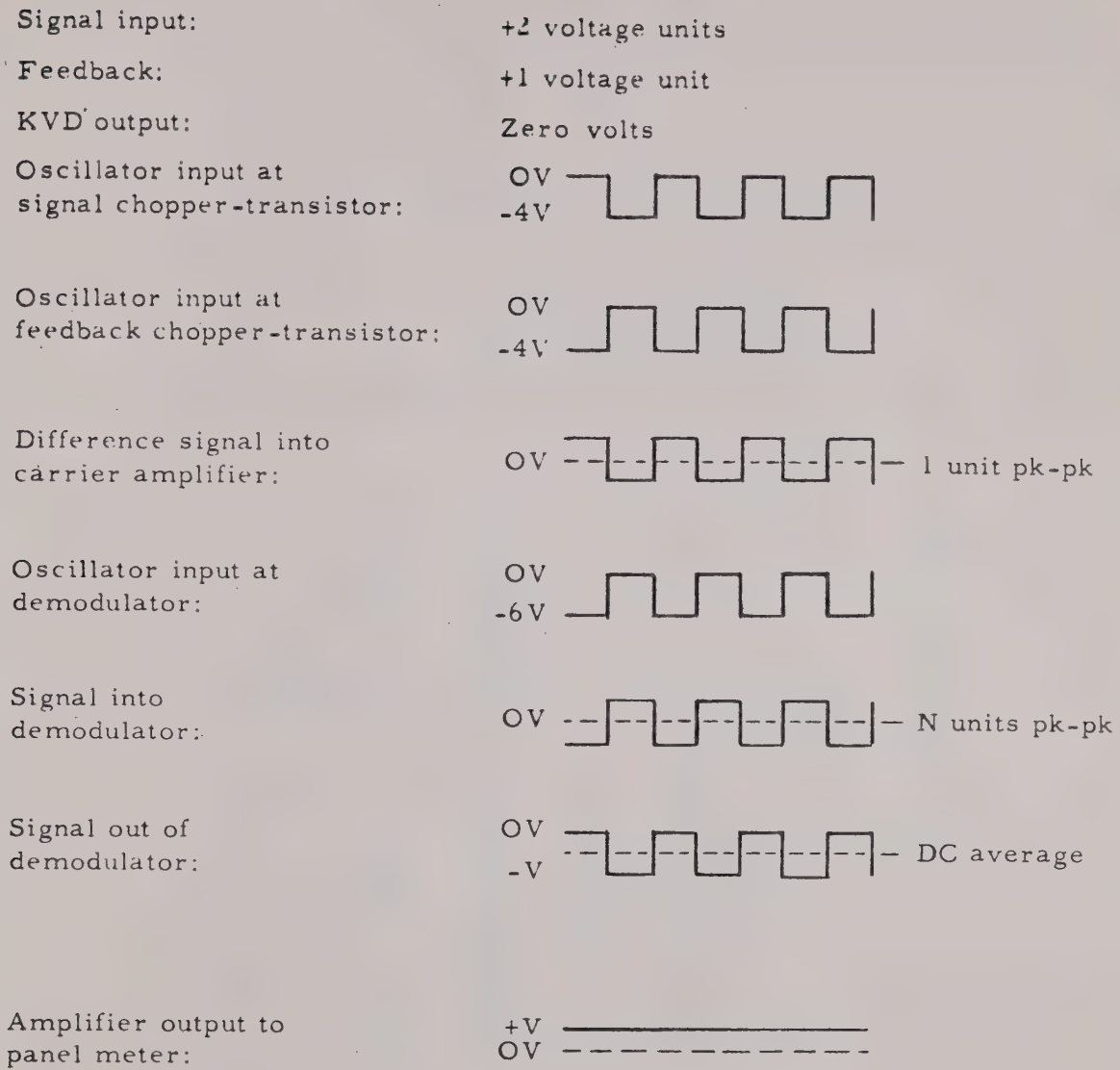


Figure 3.3. Amplifier Phase Relationships

Refer to the RS-11 schematic. The amplifier has a single differential stage (Q5) and a cascaded emitter follower output (Q3 and Q4). Transistor Q2, in combination with CR1, CR2 and R4, provides a stable, low TC (temperature coefficient) current source for the output section of Q5. This arrangement provides high gain and supply isolation. Q1 provides constant current to CR1 and CR2. CR1 is a low TC Zener and CR2 compensates for temperature changes in the base-emitter junction of Q2.

The bridge, formed by R10 through R20, CR5 and CR6, furnishes an output voltage that is a function of temperature. This correcting voltage, adjustable at R16, adds (or subtracts) a small amount to to reference voltage for precise temperature compensation. The reference diode is CR7, with R21 providing a stable current. Resistors R22, R23 and R24 make up the voltage-setting divider, with R25 and R26 providing a fine voltage adjustment.

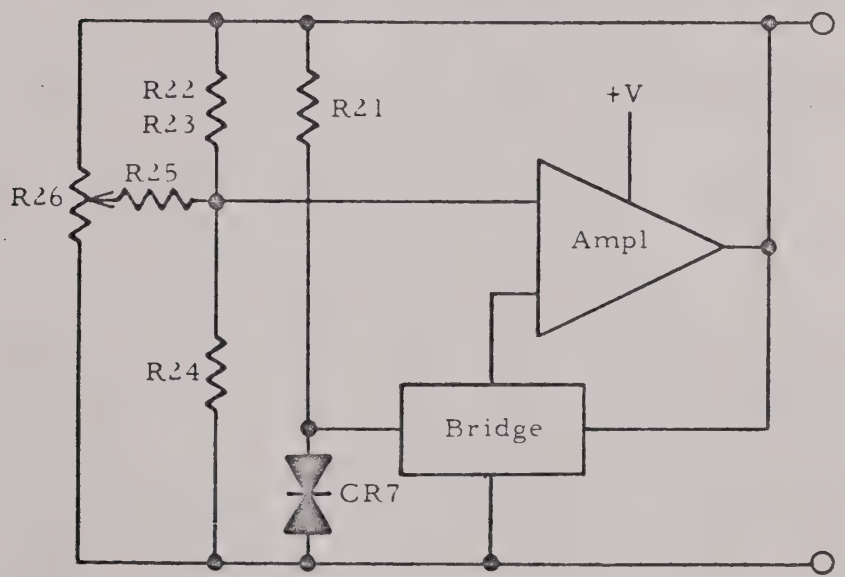


Figure 3.4. Reference Supply Block Diagram

3.2.8 Kelvin-Varley Divider

The KVD presents a constant 22 kilohm load to the selected reference regardless of the decade switch positions. The divider consists of six resistive decades that are controlled by decade

switches S5 through S10. Each switch position selects a voltage corresponding to the decimal value indicated by the position number in the readout. Selected voltages from each decade are additive and the total output voltage can be read directly from the readout dials.

3.2.9 AC Converter

The AC converter, shown in block form by Figure 3.5, consists of an operational amplifier, feedback network, rectifier and filter. An input of 1.1 volts rms (full scale plus 10% overrange) from the AC input attenuator is converted to +11 volts DC. The feedback network contains adjustments that set the gain of the 1 volt range in the 20 Hz to 20 KHz frequency range. Adjustments for the higher voltage ranges are located in the AC input attenuator.

The operational amplifier has three stages of amplification and an emitter follower output stage. V401 is the input stage, Q402 is the second stage, and Q403 is the third stage. Transistors Q404 and Q405 are interconnected to form the output stage.

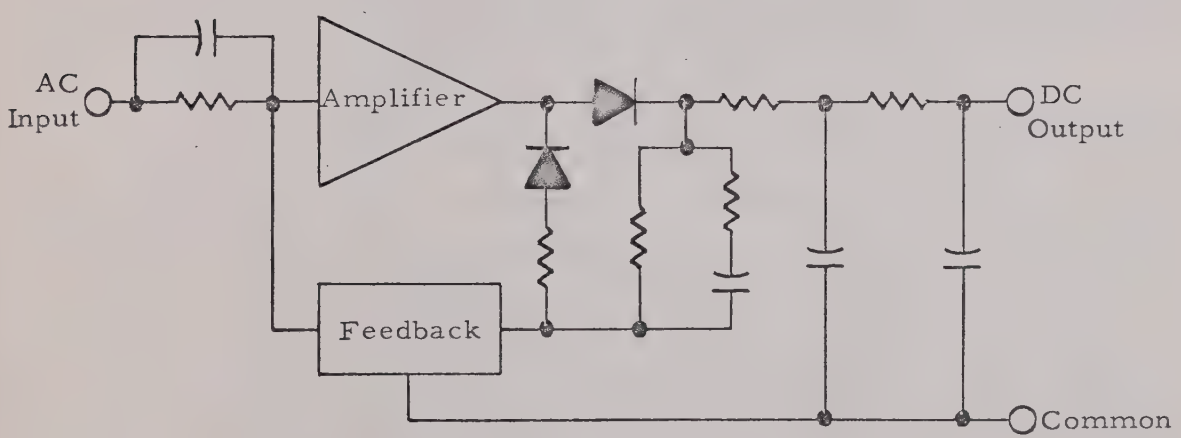


Figure 3.5. AC Converter Block Diagram

3.2.10 AC Converter Power Supply

The AC converter power supply furnishes filtered, regulated DC voltages to the AC converter, +5.5 volts and +97 volts. Three transistors within the supply, Q408, Q410 and Q419 are connected to operate as Zener diodes. The +5.5 volt supply provides the filament voltage for V401 in the AC converter and the +97 volt supply provides power for the remaining converter circuits.

SECTION IV
CALIBRATION

4.1 CALIBRATION SEQUENCE

The Model 1002 is calibrated and checked in the following sequence.

a. Zero and calibration of the panel meter.

b. Linearity check of the Kelvin-Varley Divider.

c. Alignment of the Kelvin-Varley Divider, if required.

d. DC range calibration.

e. AC calibration.

CAUTION

Do not move any internal adjustments until the need has been established. Inadvertent movement of internal adjustments can lead to extensive and unnecessary calibration.

4.2 REQUIRED CALIBRATION EQUIPMENT

a. Unless otherwise specified, use copper input cables, copper shorting cables, and copper cable clips throughout the calibration procedure.

b. Precision voltage divider (master divider) accurate to 1 PPM (ESI Model 1045A or equivalent).

c. Stable DC standard accurate to 5 PPM with range from 0 to 500 volts (ESI Model 1045A and Cohu Model 303A or equivalent combination).

d. Dry cell batteries as indicated in the calibration procedure.

e. Two-foot length of bare manganin wire (approximately 0.5 ohm per foot) and two-foot length of bare No. 14 copper wire.

f. AC standard accurate to ±0.02% with voltage range 0 to 1000 volts rms and frequency range 400 Hz to 20 KHz (Optimation Model 104A AC Calibration Source, Holt Model 6A Thermal Transfer Voltmeter, and Cohu Model 303A DC Voltage Standard or equivalent combination).

4.3 LOCATION OF ADJUSTMENTS

Figure 4.1 is a top view of the voltmeter without the AC circuits. The numbered items are identified as follows:

1. R117 1V CAL (DC).
2. R110 100V CAL (DC).
3. R114 1000V CAL (DC).
4. Terminal post No. 2
5. Terminal post No. 1.
6. Null detector (GPA-2).
7. C8 zero adjust.
8. R34 zero adjust.

9. C6 zero adjust.
10. R9 METER CAL.
11. Reference Supply (RS-11).
12. R26 10 volt range (DC).
13. R16 Factory adjustment (do not adjust in the field).

Figure 4.2 is a bottom view of the voltmeter without the AC circuits. The numbered items are identified as follows:

1. Matched precision resistors (1st decade) controlled by S5.
2. Matched precision resistors (2nd decade) controlled by S6.
3. Matched precision resistors (3rd decade) controlled by S7.
4. Matched precision resistors (4th decade) controlled by S8.
5. Matched precision resistors (5th decade) controlled by S9.
6. Matched precision resistors (6th decade) controlled by S10.
7. R41 1st decade alignment.
8. R55 2nd decade alignment.
9. R69 3rd decade alignment.
10. R83 4th decade alignment.

Figure 4.3 is a top view of the voltmeter with the AC circuits. The numbered items are identified as follows:

1. C10 100V 20 KHz Adj (AC).
2. R121 100V 400 Hz Adj (AC).
3. R135 1000V 400 Hz Adj (AC).
4. C13 1000V 20 KHz Adj (AC).
5. AC input attenuator cover.
6. C414 1V 20 KHz (AC).
7. AC converter cover.
8. R424 1V 400 Hz Adj. (AC).
9. C17 10V 20 KHz Adj (AC).
10. R118 10V 400 Hz Adj (AC).

Figure 4.4 is a bottom view of the voltmeter with the AC circuits. The numbered items are identified as follows:

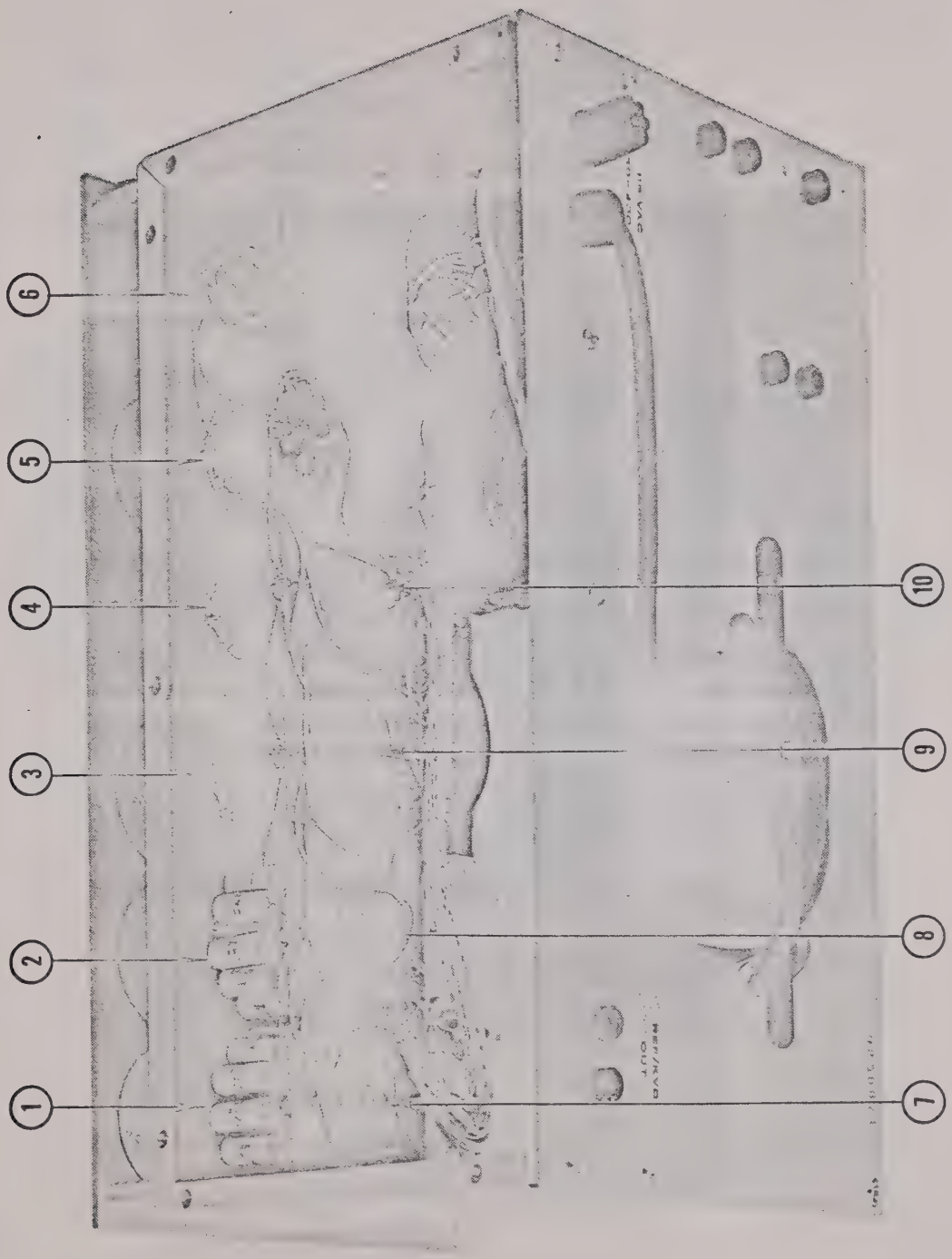
1. AC converter power supply.
2. Outside lead of R426.
3. R427 +97 volt adjustment.

4.4 CALIBRATION PROCEDURE

Disassemble the voltmeter according to paragraph 5.2.

NOTE: Numbered items are identified in paragraph 4.3.

Figure 4.1. Top view of Voltmeter without AC circuits



NOTE: Numbered items are identified in paragraph 4.3.

Figure 4.2. Bottom view of Voltmeter without AC circuits.

NOTE: Numbered items are identified in paragraph 4.3.

Figure 4.3. Top View of Voltmeter with AC Circuits

Figure 4.4. Bottom View of Voltmeter with AC Circuits

NOTE: Numbered items are identified in paragraph 4.3.

4.4.1 Zero and Calibration of Panel Meter

a. Check and adjust the mechanical zero of the panel meter according to paragraph 2.4.1.

b. Electrically zero the panel meter for DC voltage measurements according to paragraph 2.4.2. If the OPEN and SHORT CKT ZERO controls have sufficient range to zero the panel meter, proceed to paragraph 4.4.2. If not, proceed to the next step.

c. Center the OPEN and SHORT CKT ZERO controls halfway between their clockwise and counterclockwise extremities, and set R9 METER CAL (10, Figure 4.1.) fully clockwise.

d. Short the arm terminals of the OPEN and SHORT CKT ZERO potentiometers and terminal post No. 1 together. This is shown as "short A" in Figure 4.5.

e. Set the NULL switch to 10μV, the REFERENCE switch to EXT, the RANGE switch to DC VOLTS 10, and the six decade dials (S5 through S10) to zero. Short the HI and LO input terminals together until step k is reached.

f. Place a short between terminal post No. 1 and terminal post No. 2. This is shown as "short B" in Figure 4.5.

NOTE

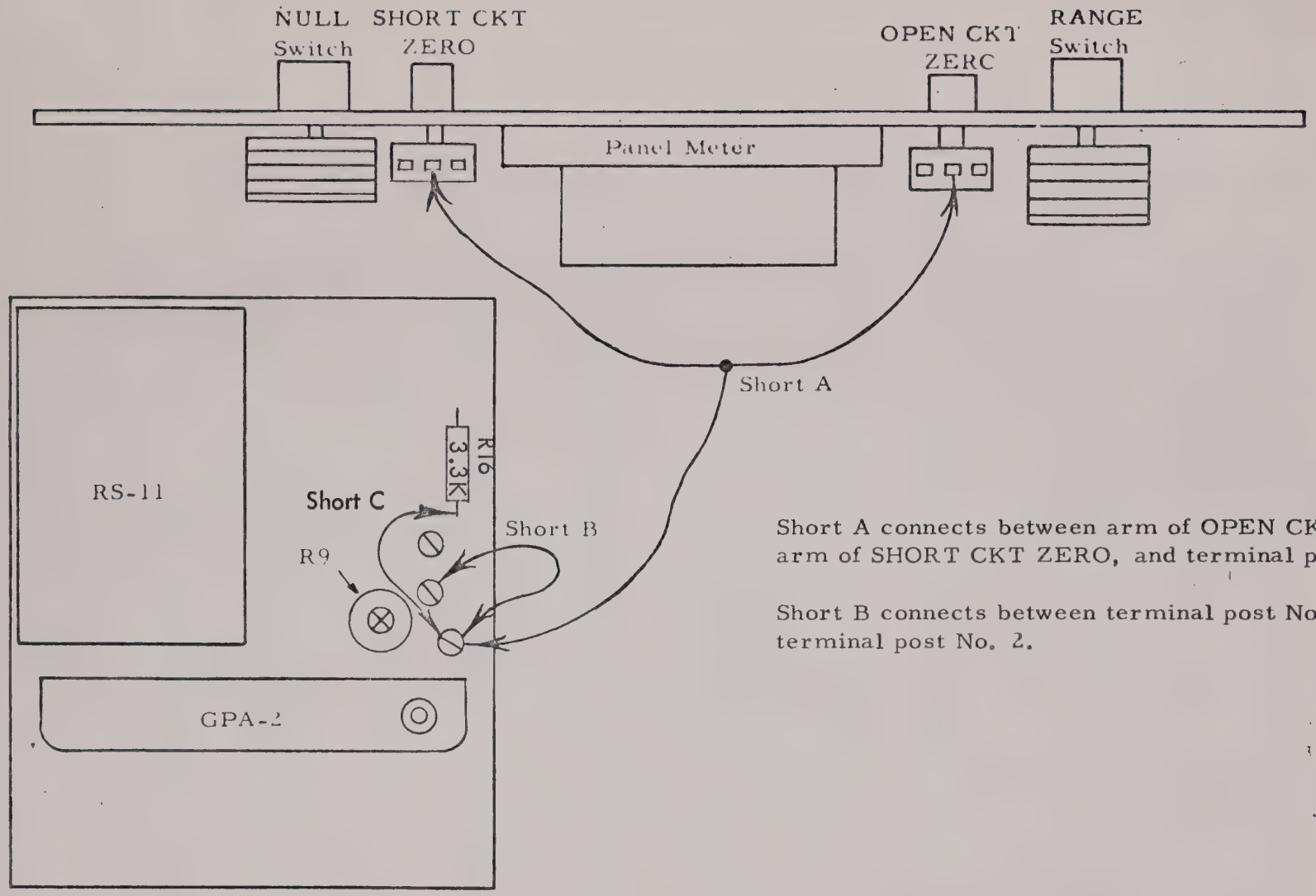
Use a non-metallic adjustment tool (JFD #5284 or equivalent) in steps g. through j. Move the adjustments in small increments and pause to let the panel meter respond.

g. With shorts A and B in place and the RANGE switch set to DC VOLTS 10, adjust R34 (8, Figure 4.1.) for a zero reading on the panel meter.

h. With the RANGE switch set to DC VOLTS 10 and short A in place, open short B and adjust C8 (7, Figure 4.1) for a zero reading on the panel meter.

i. With short A in place and short B open, set the RANGE switch to DC VOLTS 100 and adjust C6 (9, Figure 4.1.) for a zero reading on the panel meter.

j. Repeat steps g, h, and i to eliminate interaction. Up to three major panel meter divisions (±3 microvolts) are acceptable when the RANGE switch is set to DC VOLTS 100 (step i), and up to 1.5 major divisions (±1.5 microvolts) are acceptable when the RANGE switch is set to DC VOLTS 10 (steps g and h).



Short A connects between arm of OPEN CKT ZERO, arm of SHORT CKT ZERO, and terminal post No. 1.

Short B connects between terminal post No. 1 and terminal post No. 2.

Figure 4.5. Zero Calibration Setup

k. Remove shorts A and B, and remove the short from the HI and LO input terminals.

l. Electrically zero the panel meter for DC measurements according to paragraph 2.4.2.

m. Set the NULL switch to TVM, the RANGE switch to DC VOLTS 10, and the REFERENCE switch to AC/POS.

n. Connect the HI and LO input leads to a +10 volt source (accurate to 1% or better) and adjust R9 METER CAL (10, Figure 4.1) for a +10 volt reading (10 major divisions to the right of zero) on the panel meter. Disconnect the input leads from the DC source.

4.4.2 Kelvin-Varley Divider Linearity Check

The linearity of the Kelvin-Varley Divider is checked by comparing the KVD against a known master divider (ESI Model 1045A or equivalent).

a. Construct the test setup shown in Figure 4.6, and connect the GND terminal (chassis ground) of the voltmeter to chassis ground on the master divider. Set POWER switch to ON and allow the voltmeter to warmup for at least 30 minutes.

b. Set the RANGE switch to DC VOLTS 10, the REFERENCE switch to EXT, the NULL switch to 100μV, and the six decade dials to zero. Set all master divider dials to zero.

c. Adjust Clip A (Figure 4.6) along the copper wire to obtain a zero reading on the panel meter. Set the NULL switch to 10μV and further adjust Clip A to obtain a zero on the panel meter.

d. Set the NULL switch to 10V, and the six decade dials to read: 99999(10). Set the master divider dials to read: 999999(10).

NOTE

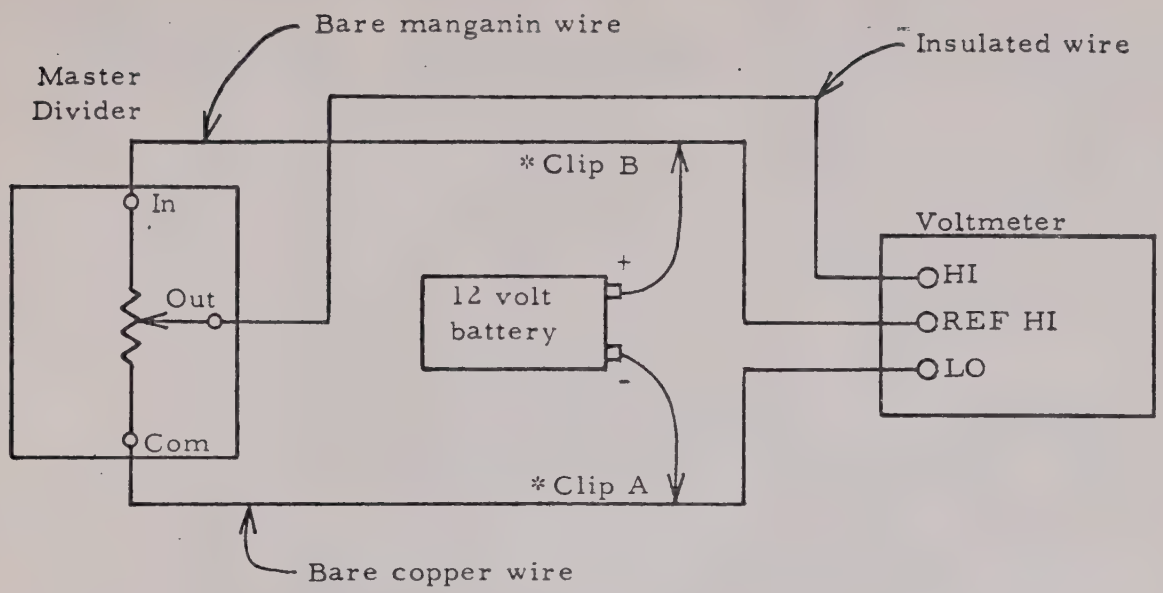
Position 10 of the least significant decade is indicated by (10).

e. Adjust Clip B (Figure 4.6) along the manganin wire to obtain a zero reading on the panel meter. Continue to adjust Clip B to obtain the zero reading while stepping the NULL switch to the 10μV position.

f. Recondition the voltmeter and master divider as indicated in step b. and repeat step c. to eliminate interaction.

NOTE

Do not move Clips A and B during the linearity check that follows.



*Clips are moved along bare wires to compensate for lead resistance.

Figure 4.6. Setup for Linearity Check

g. Set the NULL switch to TVM and set the master divider dials to read: 1111110. (The RANGE switch is set to DC VOLTS 10 and the REFERENCE switch to EXT throughout the the remainder of this check). While stepping the NULL switch toward the 10μV position, adjust the six decade dials to obtain a zero on the panel meter. With the NULL switch set to 10μV, the allowable error on the decade dials is ±1 digit, (any reading from 111110 to 111112, inclusive).

h. Follow the procedure in step g to check the Kelvin-Varley Divider at the settings indicated in Table 4.1.

Table 4.1. Linearity Settings and Tolerances

MASTER DIVIDER DIAL SETTINGS	FINAL NULL SWITCH SETTING	ALLOWABLE ERROR	INCLUSIVE READINGS ON DECADE DIALS
2222220	10μV	±2 Digits	222220 to 222224
3333330	10μV	±3 Digits	333330 to 333336
4444440	10μV	±4 Digits	444440 to 444448
5555550	10μV	±5 Digits	555550 to 555560

Table 4.1. Linearity Settings and Tolerances

MASTER DIVIDER DIAL SETTINGS	FINAL NULL SWITCH SETTING	ALLOWABLE ERROR	INCLUSIVE READINGS ON DECADE DIALS
6666660	10μV	±6 Digits	666660 to 666672
7777770	10μV	±7 Digits	777770 to 777784
8888880	10μV	±8 Digits	888880 to 888896

4.4.3 Kelvin-Varley Divider Alignment

Alignment of the Kelvin-Varley Divider is a factory calibration procedure and is seldom required in the field. Proceed with alignment only when the linearity checks in paragraph 4.4.2 have shown the Kelvin-Varley Divider to be out of tolerance. Except for the most exacting laboratory requirements, even greater tolerances, than those listed in paragraph 4.4.2, should be allowed. The KVD should also be aligned when decade resistors are replaced in the field (paragraph 5.3).

a. Set the POWER switch to OFF and stand the voltmeter on its left side (as viewed from the front).

b. Using four identical copper leads (insulated) with copper clips, make connections between the 4th decade (switch S8), a 6 volt battery and the HI input terminal as indicated in Figure 4.7.

(1) Lead #1 connects between the negative battery terminal and the junction of R76 and R77.

(2) Lead #2 connects between the negative battery terminal and the junction of R70 and R81.

(3) Lead #3 connects between the positive battery terminal and the junction of R78 and R79.

(4) Lead #4 connects between the front panel HI input terminal and the junction of R77 and R78.

c. Set the POWER switch to ON, REFERENCE switch to EXT, RANGE switch to DC VOLTS 10, NULL switch to TVM, and the six decade dials to read; 00009(10). Allow the voltmeter to warmup for at least 30 minutes.

d. While stepping the NULL switch to the 100μV position, adjust R83 (10, Figure 4.2) for a zero reading on the panel meter.

NOTE

R83, R69, R55 and R41 are sensitive adjustments and only slight movements are required to cause large swings of the meter pointer.

e. Set the POWER switch to OFF and remove the copper leads.

f. Connect the four copper leads between the 3rd decade (switch S7), the 6 volt battery and the HI input terminal as indicated in Figure 4.7.

(1) Lead #1 connects between the negative battery terminal and the junction of R62 and R63.

(2) Lead #2 connects between the negative battery terminal and the junction of R56 and R67.

(3) Lead #3 connects between the positive battery terminal and the junction of R64 and R65.

(4) Lead #4 connects between the front panel HI input terminal and the junction of R63 and R64.

g. Set the POWER switch to ON, REFERENCE switch to EXT, RANGE switch to DC VOLTS 10, NULL switch to TVM, and the six decade dials to read: 00099(10). Allow the voltmeter to warmup before proceeding.

h. While stepping the NULL switch to the 100μV position, adjust R69(9, Figure 4.2) for a zero reading on the panel meter.

i. Set the POWER switch to OFF and remove the copper leads.

j. Connect the four copper leads between the 2nd decade (switch S6), the 6 volt battery and the HI input terminal as indicated in Figure 4.7.

(1) Lead #1 connects between the negative battery terminal and the junction of R48 and R49.

(2) Lead #2 connects between the negative battery terminal and the junction of R42 and R53.

(3) Lead #3 connects between the positive battery terminal and the junction of R 50 and R51.

(4) Lead #4 connects between the front panel HI input terminal and the junction of R49 and R50.

k. Set the POWER switch to ON, REFERENCE switch to EXT, RANGE switch to DC VOLTS 10, NULL switch to TVM, and the six decade dials to read: 00999(10). Allow the voltmeter to warmup before proceeding.

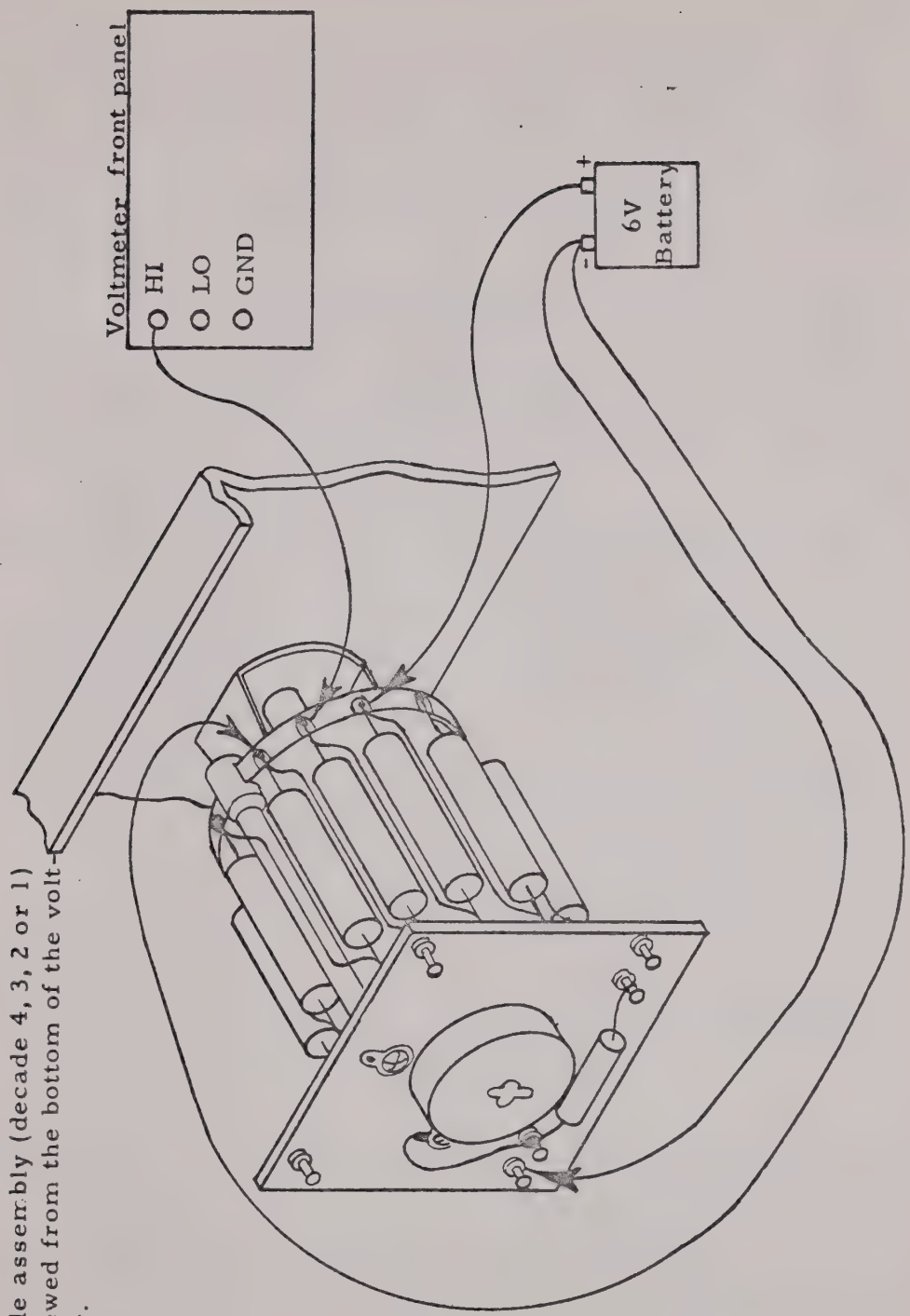


Figure 4.7. Setup for KVD Alignment

l. While stepping the NULL switch to the 100μV position, adjust R55 (8, Figure 4.2) for a zero reading on the panel meter.

m. Set the POWER switch to OFF and remove the copper leads.

n. Connect the four copper leads between the 1st decade (switch S5), the 6 volt battery and the HI input terminal as indicated in Figure 4.7.

(1) Lead #1 connects between the negative battery terminal and the junction of R34 and R35.

(2) Lead #2 connects between the negative battery terminal and the junction of R39 and R42.

(3) Lead #3 connects between the positive battery terminal and the junction of R36 and R37.

(4) Lead #4 connects between the front panel HI input terminal and the junction of R35 and R36.

o. Set the POWER switch to ON, REFERENCE switch to EXT, RANGE switch to DC VOLTS 10, NULL switch to TVM, and the six decade dials to read: 09999(10). Allow the voltmeter to warmup before proceeding.

p. While stepping the NULL switch to the 100μV position, adjust R41 (7, Figure 4.2) for a zero reading on the panel meter.

q. Set the POWER switch to OFF and remove the copper leads.

r. Perform the linearity checks in paragraph 4.4.2 to determine that the Kelvin-Varley Divider is properly aligned.

4.4.4 DC Range Calibration

a. Interconnect the voltmeter with the DC standard (ESI Model 1045A or equivalent) as shown in Figure 4.8.

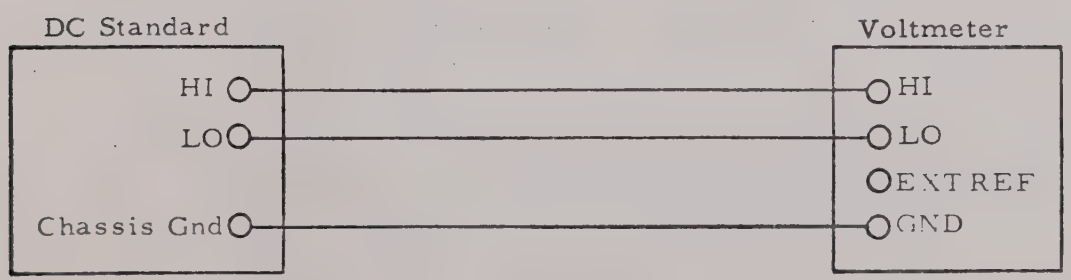


Figure 4.8. DC Range Calibration Setup

b. Set the POWER switch to ON and allow the voltmeter at least 30 minutes warmup.

c. Set the REFERENCE switch to AC/POS, the RANGE switch to DC VOLTS 10, the NULL switch to TVM, and the six decade dials to read: (10)9999(10). Adjust the DC standard to supply +11 volts ±0.0005% to the voltmeter.

CAUTION

Do not adjust R16 (13, Figure 4.1) on the reference supply. R16 is adjusted only at the factory with specialized test equipment.

d. While stepping the NULL switch to the 10μV position, adjust R26 (12, Figure 4.1) on the reference supply for zero on the panel meter.

e. Set the RANGE switch to DC VOLTS 1, the NULL switch to TVM, and the six decade dials to read: (10)9999(10). Adjust the DC standard to supply 1.1 volts ±0.0005% to the voltmeter.

f. While stepping the NULL switch to the 10μV position, adjust 1V CAL R117 (1, Figure 4.1) for zero on the panel meter.

g. Set the RANGE switch to DC VOLTS 100, the NULL switch to TVM, and the six decade dials to read: (10)9999(10). Adjust the DC standard to supply +110 volts ±0.001% to the voltmeter.

NOTE

It is desirable to calibrate the 100 and 1000 volt ranges using a DC standard that is accurate to ±0.0005%, however, a more readily obtainable accuracy, ±0.001%, is specified in steps g and i.

h. While stepping the NULL switch to the 10μV position, adjust 100V CAL R110 (2, Fig. 4.1) for zero on the panel meter.

i. Set the RANGE switch to DC VOLTS 1000, the NULL switch to TVM, and the six decade dials to read: 500000. Adjust the DC standard to supply +500 volts ±0.001% to the voltmeter.

j. While stepping the NULL switch to the 10μV position, adjust 1000V CAL R114 (3, Figure 4.1) for zero on the panel meter.

4.4.5 AC Converter Power Supply Calibration

a. Set the POWER switch to ON.

WARNING

The potential between the case of potentiometer R427 (3, Figure 4.4) and the chassis is approximately +90 volts DC.

b. Measure the potential between the outside lead of R426 (2, Figure 4.4 - adjacent to R427) and common (rear panel terminal J12). The potential should be +97 ±1 volts DC. If not, use an insulated tool to adjust R427 to obtain this potential.

4.4.6 AC Range Calibration

The 10, 100 and 1000 volt AC ranges, although independent of each other, must be calibrated after the 1 volt AC range.

a. Interconnect the voltmeter with the AC standard (refer to paragraph 4.2f) as shown in Figure 4.9.

b. Set the POWER switch to ON and allow the voltmeter at least 30 minutes warmup.

c. Set the REFERENCE switch to AC/POS, the RANGE switch to AC VOLTS 1, the NULL switch to TVM, and the six decade dials to read: .(10)00000.

d. Adjust the AC standard to supply 1 volt rms ±0.02%, 400 Hz to the voltmeter. While stepping the NULL switch to the 1MV position, adjust R424 1V 400 Hz ADJ (8, Figure 4.3) on the AC converter for zero on the panel meter.

e. Maintain the input from the AC standard at 1 volt rms and increase the frequency to 20 KHz. Adjust C414 1V 20 KHz ADJ (6, Figure 4.3) on the AC converter for zero on the panel meter.

f. Repeat steps d and e to eliminate interaction.

g. Set the RANGE switch to AC VOLTS 10, the NULL switch to TVM, and the six decade dials to read: (10).00000.

h. Adjust the AC standard to supply 10 volts rms ±0.02%, 400 Hz to the voltmeter. While stepping the NULL switch to the 1 MV position, adjust R118 10V 400 Hz ADJ (10, Figure 4.3) on the AC input attenuator for zero on the panel meter.

i. Maintain the input from the AC standard at 10 volts rms and increase the frequency to 20 KHz. Adjust C17 10V 20 KHz ADJ (9, Figure 4.3) on the AC input attenuator for zero on the panel meter.

j. Repeat steps h and i to eliminate interaction.

k. Set the RANGE switch to AC VOLTS 100, the NULL switch to TVM, and the six decade dials to read: (10)0.0000.

l. Adjust the AC standard to supply 100 volts rms ±0.02%, 400 Hz to the voltmeter. While stepping the NULL switch to the 1MV position, adjust R121 100V 400 Hz ADJ (2, Figure 4.3) on the AC input attenuator for zero on the panel meter.

m. Maintain the input from the AC standard at 100 volts rms and increase the frequency to 20 KHz. Adjust C10 100V 20 KHz ADJ (1, Figure 4.3) on the AC input attenuator for zero on the panel meter.

n. Repeat steps l and m to eliminate interaction.

o. Set the RANGE switch to AC VOLTS 1000, the NULL switch to TVM, and the six decade dials to read: (10)00.000.

p. Adjust the AC standard to supply 1000 volts rms ±0.02%, 400 Hz to the voltmeter. While stepping the NULL switch to the 1MV position, adjust R135 1000V 400 Hz ADJ (3, Figure 4.3) on the AC input attenuator for zero on the panel meter.

q. Maintain the input from the AC standard at 1000 volts rms and increase the frequency to 20 KHz. Adjust C13 1000V 20 KHz ADJ (4, Figure 4.3) on the AC input attenuator for zero on the panel meter.

r. Repeat steps p and q to eliminate interaction.

This completes the calibration procedure.

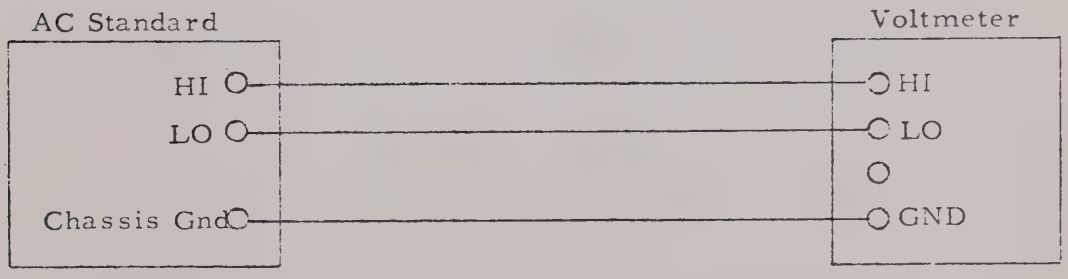


Figure 4.9. AC Range Calibration

SECTION V

MAINTENANCE

5.1 GENERAL

When operated within the specified limits, the voltmeter should maintain high performance standards for an extended period. No preventive maintenance is required except for routine cleaning. If the instrument shows signs of erratic or out-of-tolerance measurements, calibrate the meter as required (Section IV).

5.2 DISASSEMBLY

To remove the top cover, remove four screws (two on each side of the instrument) and lift cover from the instrument. To remove the bottom panel, remove seven screws on the bottom of instrument and lift the panel from the instrument.

NOTE

It is not necessary to remove the screws retaining the rubber feet.

5.3 REPLACEMENT OF KVD RESISTORS

Each decade switch of the Kelvin-Varley Divider contains a matched set of precision resistors that seldom require replacement. However, if a decade resistor is found to be defective, the complete decade switch assembly must be replaced. When ordering replacements, include the model and serial numbers.

5.4 GPA-2 AND RS-11 REPAIRS

Special test equipment is used to determine the final values of many components on the GPA-2 and RS-11 plug-in cards. This equipment is not normally available in the field, therefore, it is recommended that the cards be returned to the factory for repair when the following components are faulty:

a. Components designated as "select on test".

b. Precision, wire-wound resistors.

c. Zener diodes.

d. Matched components (transistors, resistors, etc.).

e. Dual-transistor Q5 or TC bridge resistors on the RS-11 card.

f. Field effect transistors on the GPA-2 card.

5.5 CORRECTIVE MAINTENANCE

In the event of malfunction in any circuit or component, normal troubleshooting techniques should be adopted. All plugs, leads, connectors, power supply voltages and the fuse should be carefully checked. All plug-in circuit cards (GPA-2 and RS-11) should be inspected to ensure that they are firmly seated.

A list of adverse symptoms, probable causes and corrective procedures is provided in Table 5.1. To use the information provided in the table, first consult the symptom column until an observed condition is recognized. Next consult the successive right-hand columns for the probable cause and the appropriate corrective procedure.

Troubleshooting of the AC voltage measurement circuits should not be started until it has been determined that the DC voltage measurement circuits are functioning correctly and are in calibration.

Table 5.1. Troubleshooting Guide

Symptom	Probable Cause	Suggested Remedy
1. Voltmeter faulty in all operations modes & ranges.	Null detector and its associated circuits.	Zero and calibrate the panel meter (paragraph 4.4.1) check null detector explained in paragraph 3.2.6, check feedback circuits explained in paragraph 3.2.5 (read paragraph 5.4 before repairing GPA-2).
2. Pointer of panel meter always at full scale in one or more positions of NULL switch.	Open in the TVM/NULL attenuators.	Attenuators are explained in paragraph 3.2.4, check for open circuit or resistor at section C of S1 or sections B & C of S2.
3. Faulty AC, DC & ratio measurements in all ranges; TVM mode is correct.	Kelvin-Varley Divider.	Check KVD linearity (paragraph 4.4.2), align KVD (paragraph 4.4.3), KVD is explained in paragraph 3.2.8. (Read paragraph 5.3 before attempting repairs).

Table 5.1. Troubleshooting Guide (continued)

Symptom	Probable Cause	Suggested Remedy
4. AC & DC measurements incorrect in all ranges but ratio measurements are correct.	Reference Supply (RS-11)	Check DC range calibration paragraph 4.4.4), RS-11 is explained in paragraph 3.2.7. (Read paragraph 5.4 before attempting repairs.)
5. Voltmeter drifts in all AC & DC ranges, ratio ranges are correct.	a. Reference supply b. Reference power supply	a. See step 4. b. Check Zener CR9 & regulation of the line voltage.
6. DC & ratio faulty in 1 volt range, but correct in other positions of S2.	Reference Attenuator.	Attenuator is explained in paragraph 3.2.3, check 1V CAL adjustments and its series resistors. Check DC range calibration (paragraph 4.4.4).
7. DC & ratio faulty in 100 volt range, but correct in other positions of S2.	DC input attenuator	Check DC range calibration (paragraph 4.4.4), attenuator is explained in paragraph 3.2.2, check 100V CAL adjustment and associated resistors.
8. DC & ratio faulty in 1000 volt range, but correct in other positions of S2.	DC Input attenuator	See step 7 and check 1000V CAL adjustment and associated resistors.
9. DC & ratio faulty in 100 and 1000 volt ranges, but correct in 1 & 10 volt ranges.	DC Input attenuator.	See step 7 and check resistors controlled by section F of S2.
10. All AC measurements are faulty. DC & ratio are correct.	a. AC converter power	a. Check supply calibration (paragraph 4.4.5), circuit is explained in paragraph 3.2.10.

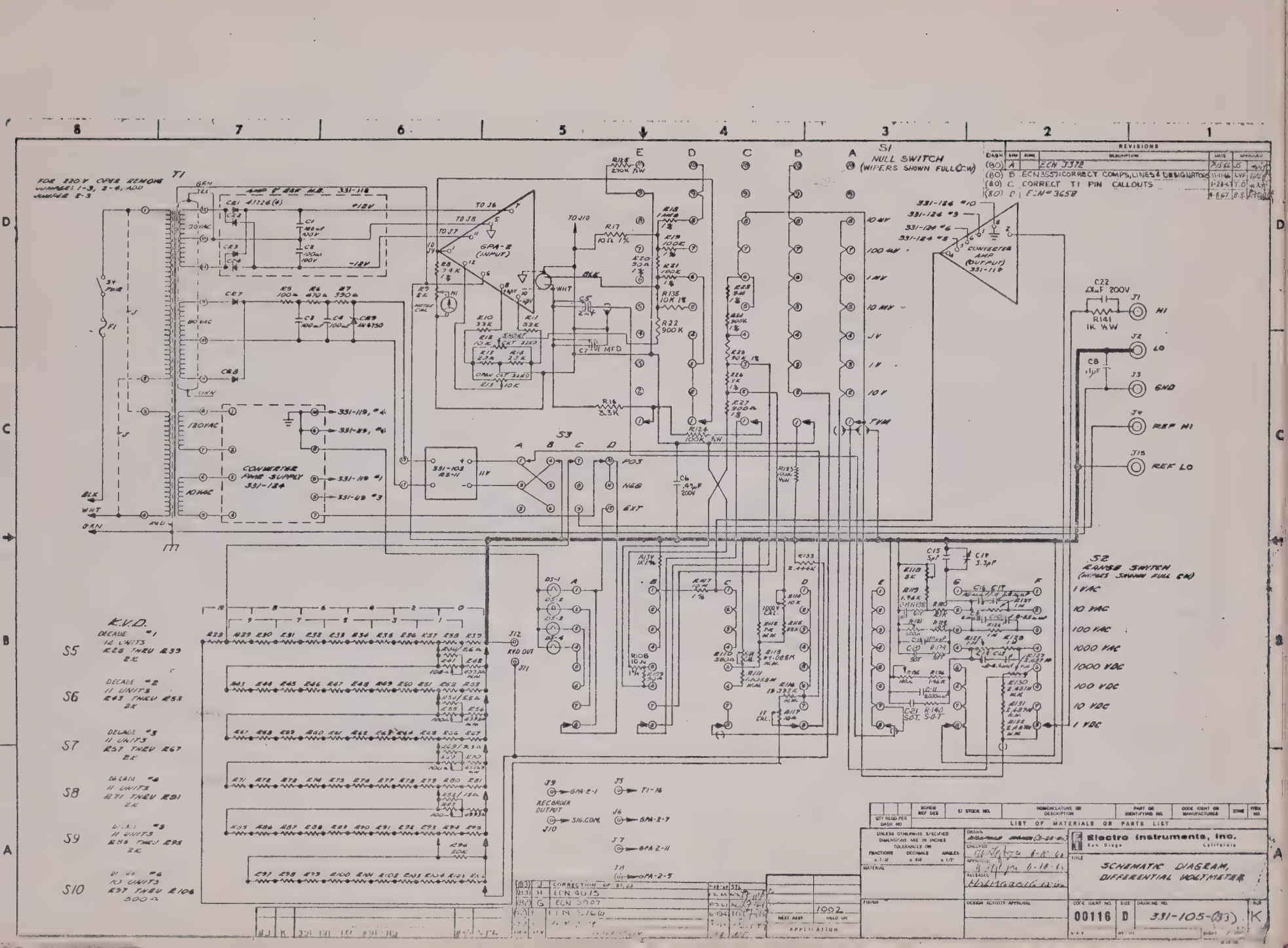
06-300

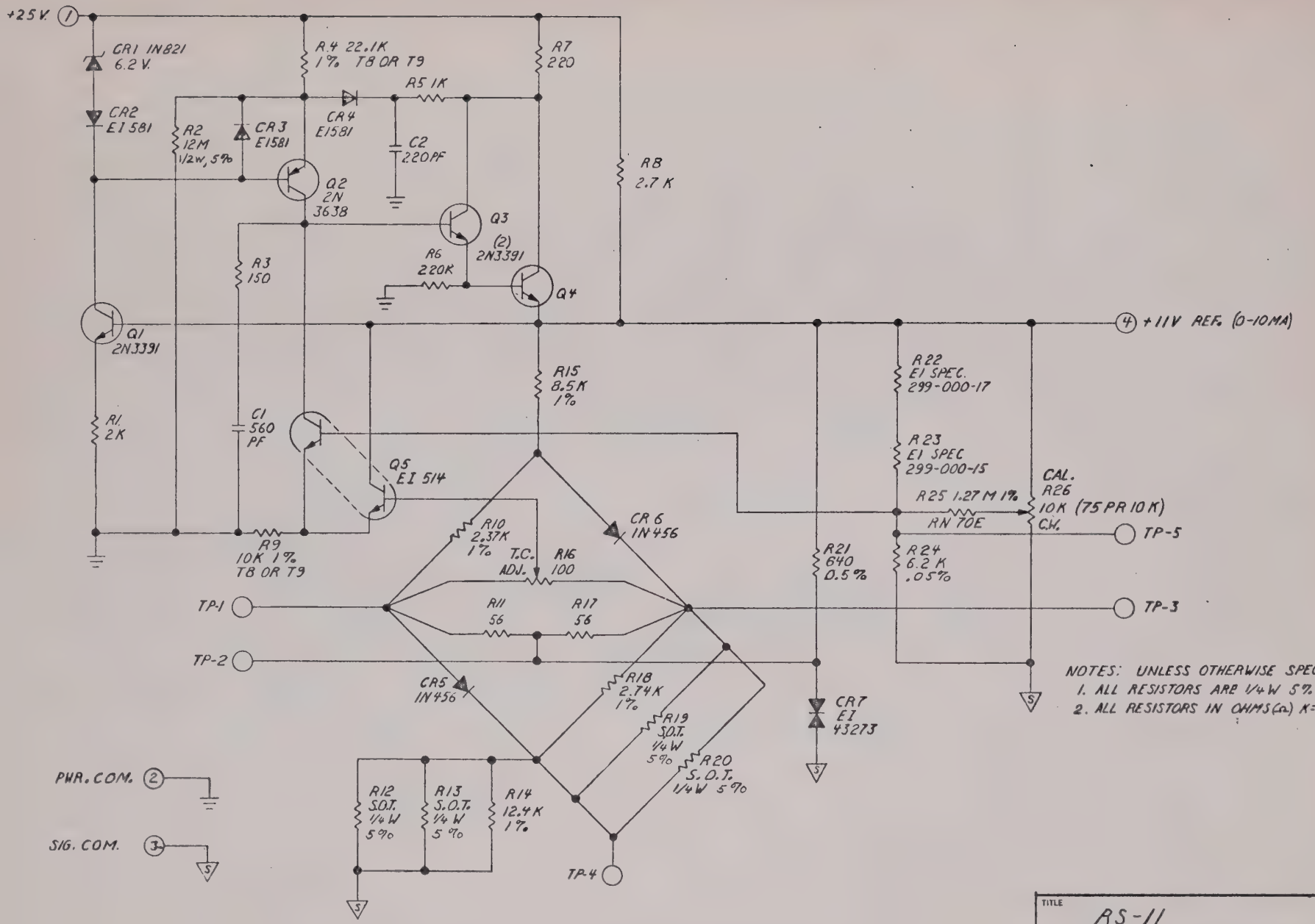
Table 5.1. Troubleshooting Guide (continued)

Symptom	Probable Cause	Suggested Remedy
	b. AC converter.	b. Check calibration of the 1 volt AC range (steps a through f of paragraph 4.4.6), circuit is explained in paragraph 3.2.9.
11. AC faulty in 10 volt range, other AC ranges are correct. DC & ratio are correct	AC input attenuator.	Circuit is explained in paragraph 3.2.1, check 10 volt calibration (paragraph 4.4.6).
12. AC faulty in 100 volt range, other AC ranges are correct. DC & ratio are correct.	AC input attenuator.	See step 11, check 100 volt calibration (paragraph 4.4.6).
13. AC faulty in 1000 volt range, other AC ranges are correct. DC & ratio are correct.	AC input attenuator.	See step 11, check 1000 volt calibration (paragraph 4.4.6).

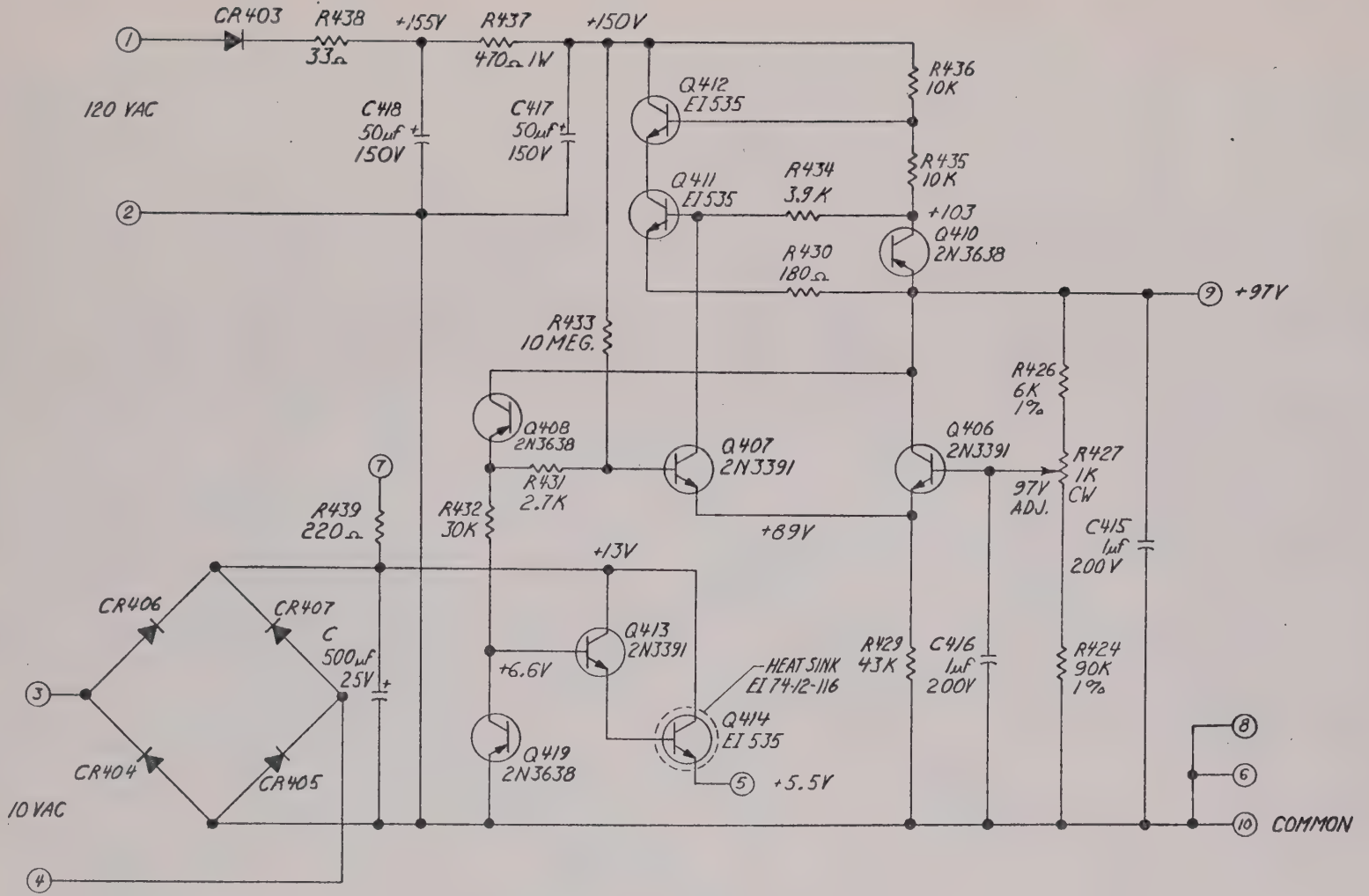
LIST OF DIFFERENTIAL VOLTMETER DRAWINGS

Nomenclature	Schematic
Schematic Diagram	331-105
GPA-2A Amplifier	501-105
RS-11 Reference Supply	331-103
AC Converter	331-121
Converter Power Supply	331-124
Wiring Diagram	331-113


S1 NULL SWITCH (WIPERS SHOWN FULL CW)
S2 RANGE SWITCH (WIPERS SHOWN FULL CW)
1 VAC
10 VAC
100 VAC
1000 VAC
1000 VDC
100 VDC
10 VDC
1 VDC
S3
POS
NEG
EXT
S5
S6
S7
S8
S9
S10
J1 HI
J2 LO
J3 GND
J4 REF HI
J15 REF LO
J12 KVD OUT
J11
RECORDER OUTPUT
J10
T1
FOR 220 V, OPEN JUMPERS 1-3, 3-4, ADD JUMPER 2-3
CONVERTER AND POWER SUPPLY 331-124
CONVERTER AND (OUTPUT) 331-118
K.V.D.
DECADE #1 11 UNITS R28 THRU R38 2K
DECADE #2 11 UNITS R43 THRU R53 2K
DECADE #3 11 UNITS R57 THRU R67 2K
DECADE #4 11 UNITS R71 THRU R81 2K
DECADE #5 11 UNITS R85 THRU R95 2K
DECADE #6 10 UNITS R97 THRU R106 300Ω
REVISIONS
(80) A ECN 3378
(80) B ECN 3557 CORRECT COMPS, LINES & DESIGNATORS
(80) C CORRECT T1 PIN CALLOUTS
(XO) D ECN 3658
LIST OF MATERIALS OR PARTS LIST
Electro Instruments, Inc.
San Diego California
SCHEMATIC DIAGRAM, DIFFERENTIAL VOLTMETER
00116 D 331-105-(83) K



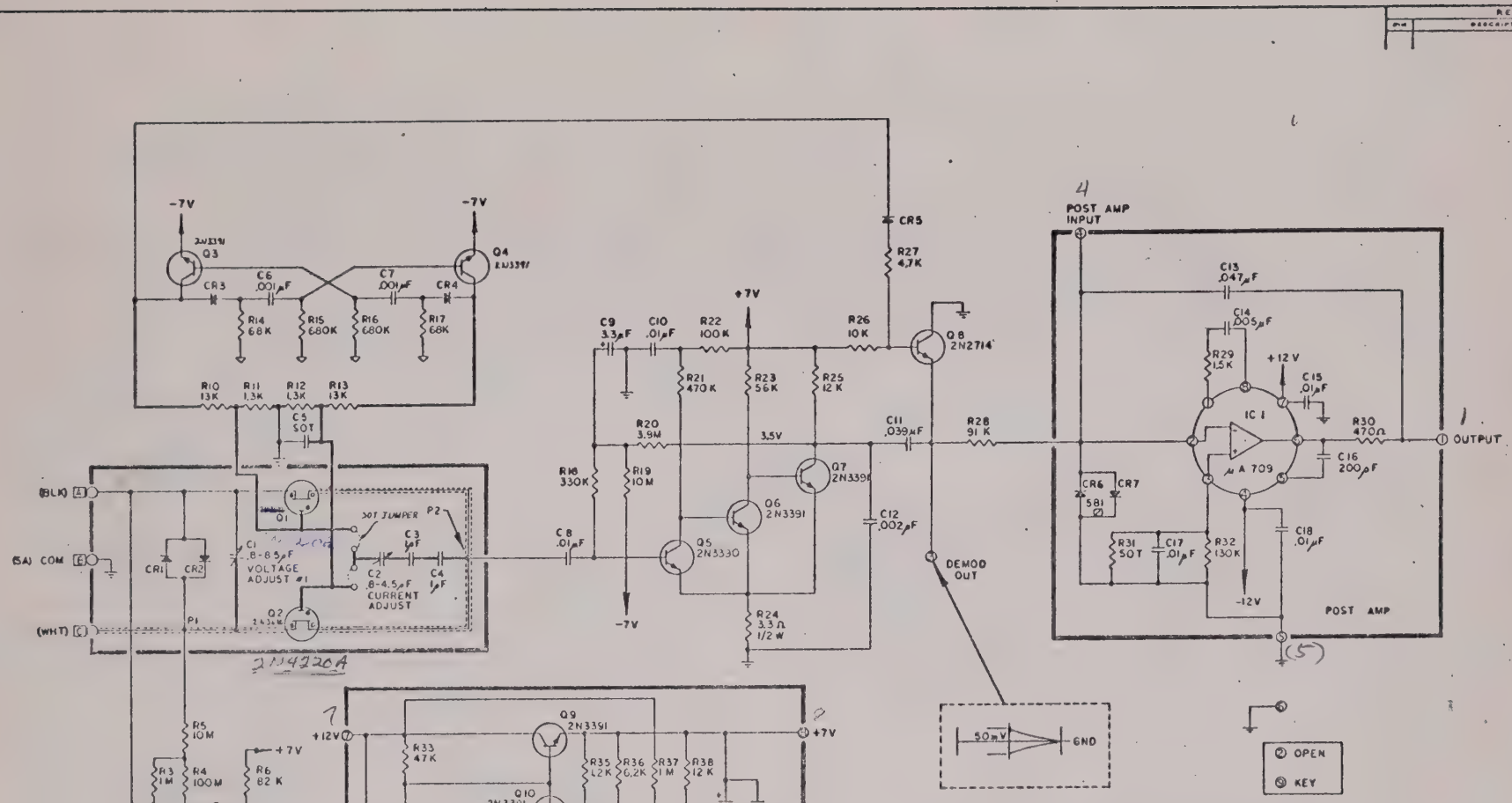
TITLE: RS-11 REF. SUPPLY			
CODE IDENT NO. 00116	SIZE C	DRAWING NO. 331-103-(80)	REV A
SCALE NONE	WEIGHT	SHEET 1 OF 1	



NOTES:

ALL RESISTORS ARE 1/2 W. ±5%
UNLESS OTHERWISE SPECIFIED

TITLE: CONVERTER POWER SUPPLY			
CODE IDENT NO. 00116	SIZE C	DRAWING NO. 331-124-(80)	REV
SCALE NONE	WEIGHT	SHEET 1 OF 1	



NOTES

1 APPLY 1mV PER PICO AMP DESIRED INPUT CURRENT CHANGE
2 ALL RESISTOR ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED
3 ——— LINES: TO BE AS SHORT AS POSSIBLE TO MINIMIZE STRAY CAPACITANCE
4 ▒▒▒▒▒ LINES: TO BE MOUNTED ON STAND OFFS

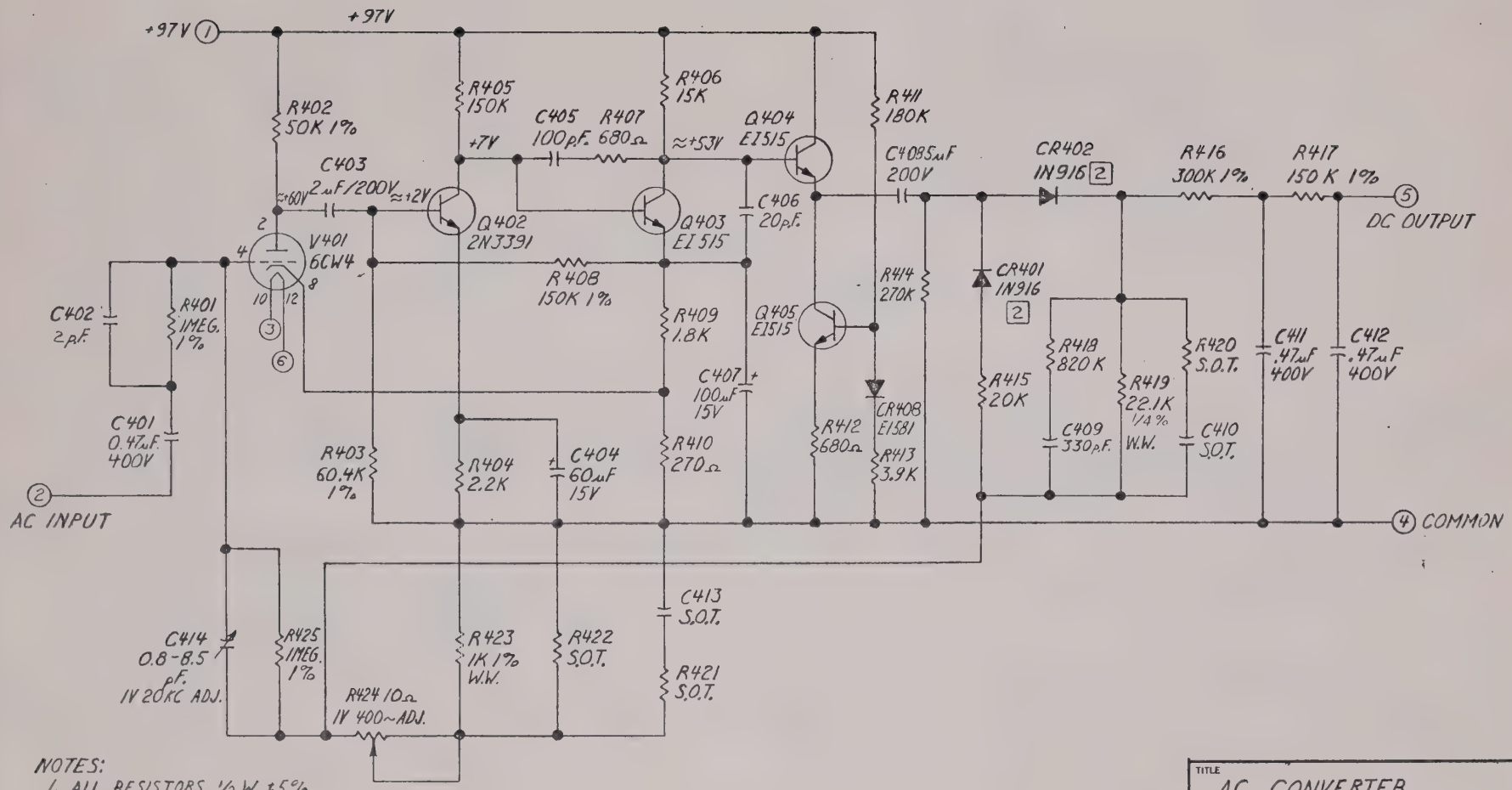
501-106-50

REVISIONS			
DWG	DESCRIPTION	BASIC	APPROVED

DWG NO.	PART NO.	DESCRIPTION
		LIST OF MATERIALS

SCHEMATIC DIAGRAM GPA-2C

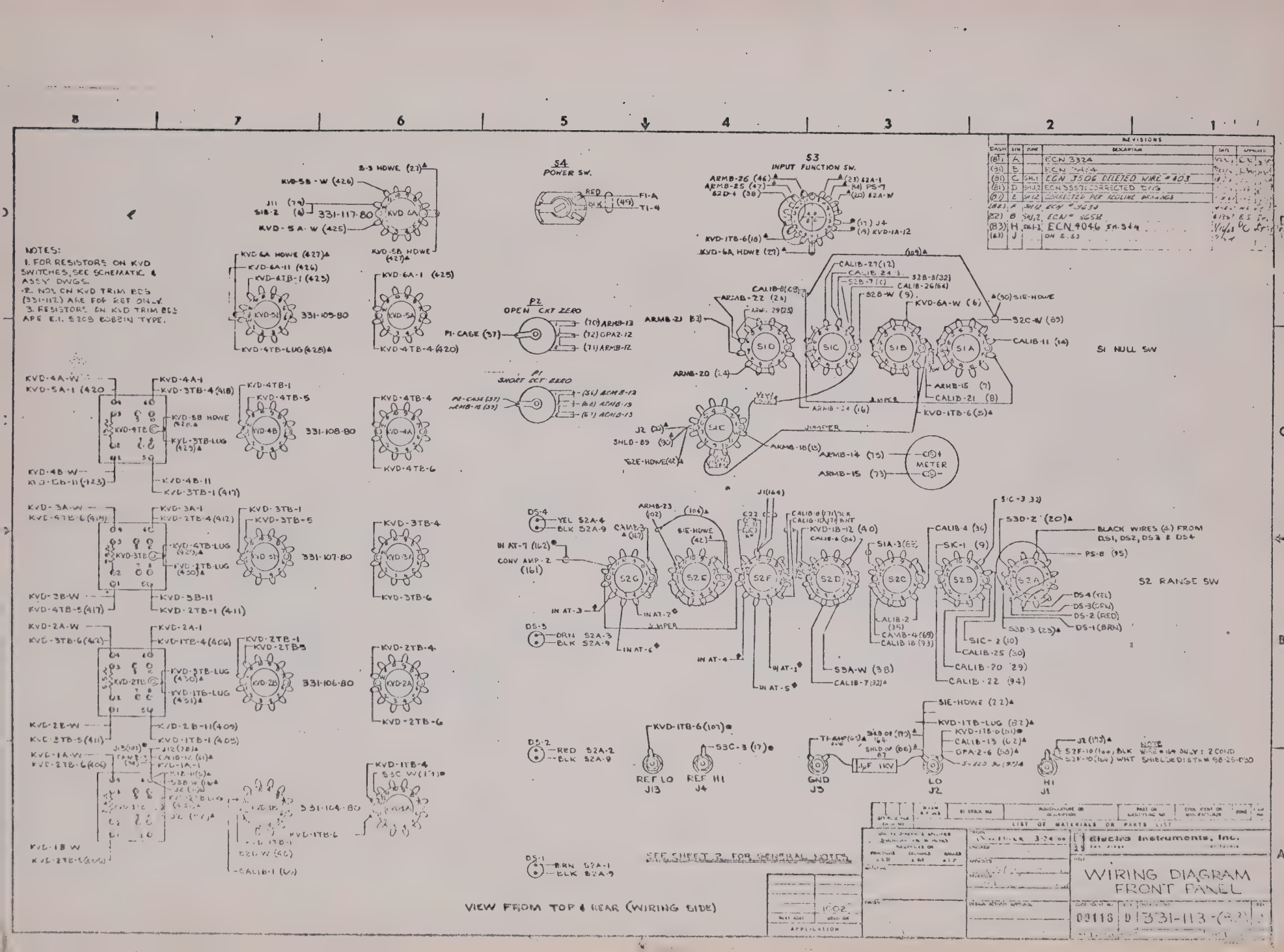
PRINCETON SYNERGETICS CORPORATION

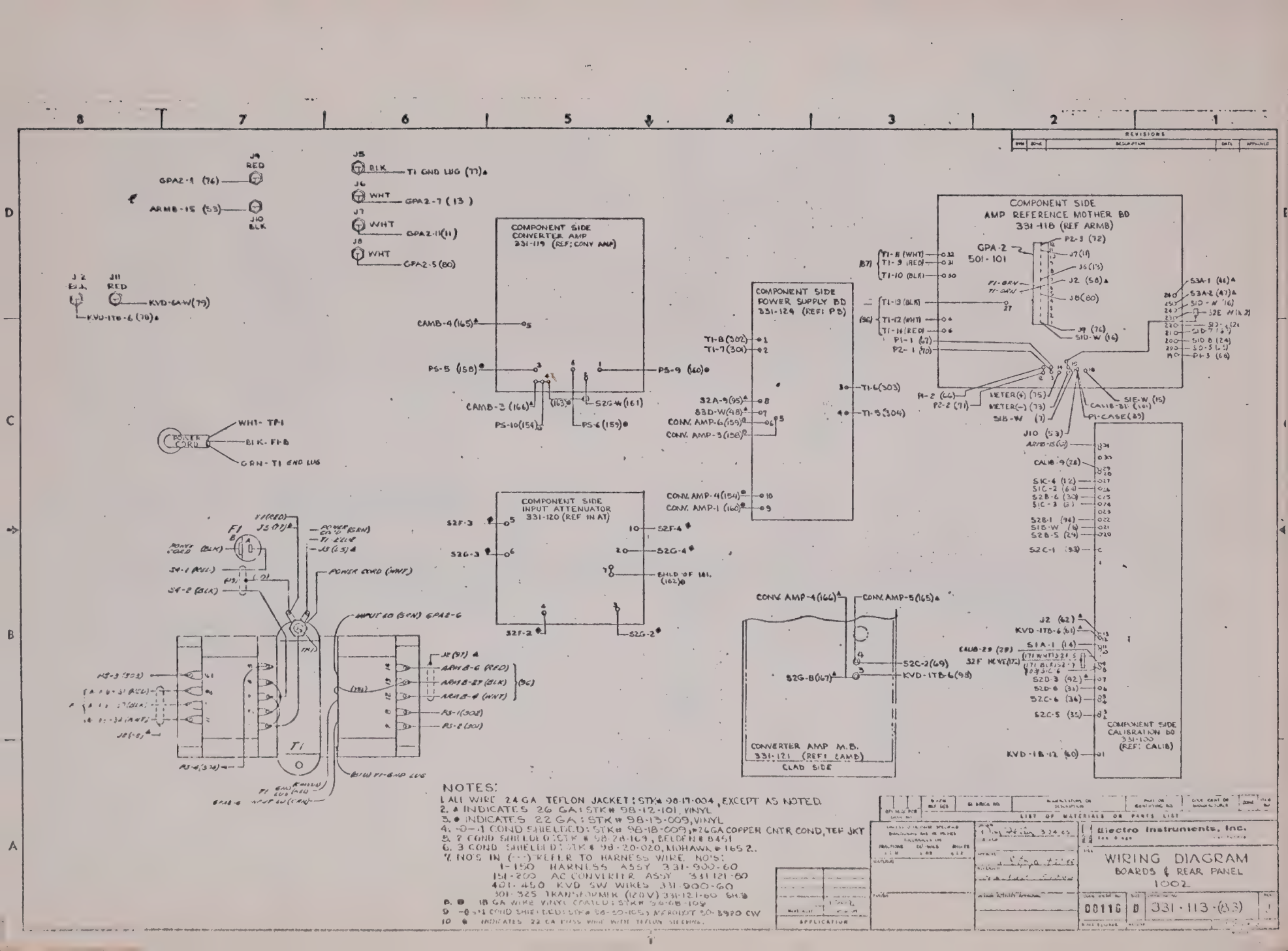


NOTES:
1. ALL RESISTORS ½ W ±5% UNLESS OTHERWISE NOTED
[2] CR401 & CR402 ARE SELECTED TO SPEC NO. 094-456-00.

TITLE: AC CONVERTER

CODE IDENT NO.	SIZE	DRAWING NO.	REV
00116	C	331-121-(B1)	B
SCALE NONE	WEIGHT	SHEET 1 OF 1	


NOTES:
1. FOR RESISTORS ON KVD SWITCHES, SEE SCHEMATIC & ASSY DWGS.
2. NOT ON KVD TRIM BDS (331-112) ARE FOR REF ON LY.
3. RESISTORS ON KVD TRIM BDS ARE E.I. 5209 BOBBIN TYPE.
S4 POWER SW.
S3 INPUT FUNCTION SW.
P2 OPEN CKT ZERO
P1 SHORT CKT ZERO
S1 NULL SW
S2 RANGE SW
331-117-80
331-105-80
331-108-80
331-107-80
331-106-80
331-104-80
VIEW FROM TOP & REAR (WIRING SIDE)
SEE SHEET 2 FOR GENERAL NOTES
REF LO J13
REF HI J4
GND J3
LO J2
HI J1
Electro Instruments, Inc.
WIRING DIAGRAM FRONT PANEL
09118
B 331-113-(4)


COMPONENT SIDE
CONVERTER AMP
331-119 (REF: CONV AMP)
COMPONENT SIDE
POWER SUPPLY BD
331-124 (REF: PS)
COMPONENT SIDE
AMP REFERENCE MOTHER BD
331-118 (REF ARMB)
GPA-2
501-101
COMPONENT SIDE
INPUT ATTENUATOR
331-120 (REF IN AT)
CONVERTER AMP M.B.
331-121 (REF: CAMB)
CLAD SIDE
COMPONENT SIDE
CALIBRATION BD
331-100
(REF: CALIB)
POWER CORD
WHT- TP-1
BLK- F1-B
GRN- T1 END LUG
NOTES:
1. ALL WIRE 24 GA TEFLON JACKET; STK# 98-17-004, EXCEPT AS NOTED
2. ▲ INDICATES 26 GA; STK# 98-12-101, VINYL
3. ● INDICATES 22 GA; STK# 98-13-009, VINYL
4. -0-1 COND SHIELDED: STK# 98-18-009, #26GA COPPER CNTR COND, TEF JKT
5. 2 COND SHIELDED; STK# 98-20-169, BELDEN # 8451
6. 3 COND SHIELDED; STK# 98-20-020, MOHAWK # 1652.
7. NOS IN (---) REFER TO HARNESS WIRE NOS:
1-150 HARNESS ASSY 331-900-60
151-200 AC CONVERTER ASSY 331-121-60
401-450 KVD SW WIRES 331-900-60
501-525 TRANSFORMER (120V) 331-121-60
8. ■ 18 GA WIRE VINYL COATED; STK# 98-08-169
9. -0-1 COND SHIELDED; STK# 98-20-165, MERCURY 50-8920 CW
10. ◆ INDICATES 22 GA PLUS WIRE WITH TEFLON SLEEVING
Electro Instruments, Inc.
WIRING DIAGRAM
BOARDS & REAR PANEL
1002
00116
D
331-113-(83)

SECTION VI – PARTS LIST

6-1 INTRODUCTION

The parts list is a breakdown of all assemblies and sub-assemblies which can be disassembled. Generally, parts are listed in order of disassembly sequence.

6-2 COLUMN EXPLANATIONS

a. References

This is a triple column which lists first the figure number of the illustration on which a particular index number will be found. The second column contains the index number of the item described. The third column lists the schematic reference designation or the item number of an electrical component.

b. Description

The item name appears in this column. Where applicable, the specification number, value, and/or reference which further identifies the item is also listed.

c. Manufacturer and Part Number

This is a double column which lists first the manufacturer's Federal Supply Code. This is a five digit code as described in the Federal Supply Code for Manufacturers (Cataloging Handbook H4-1 & H4-2). A letter code is assigned to manufacturers who do not have a Federal Supply Code Number. In some cases more than one manufacturer can supply an "or equal" part, but the intent is to show only one outside source. The second column lists the manufacturer's part number for all parts that may be ordered directly from the original manufacturer.

d. PSC Part Number

This column lists the number under which an item may be ordered directly from PRECISION STANDARDS CORP. Certain items contain only PSC part numbers. These items are proprietary items that are available only from PSC

e. Quantity per Assembly

This column lists a number which is the quantity of that item as used in a particular assembly.

f. Effectivity Code

The Effectivity Code column indicates the components which are peculiar to certain serial numbers. This is indicated by a code letter. Where the component is applicable to all serial numbers or options, the column is left blank.

The code letter(s) used in this column denotes a certain serial number(s) or options. If the Effectivity Code column is used, the breakdown of the code letters will be found in paragraph 6-8.

6-3 REFERENCE DESIGNATORS

The following lists the abbreviations used with schematic reference designators:

B	-	motor	M	-	meter
C	-	capacitor	P	-	plug
CR	-	diode	Q	-	transistor
DS	-	device signaling (lamp)	R	-	resistor
F	-	fuse	RT	-	thermistor
FL	-	filter	S	-	switch
J	-	jack	T	-	transformer
K	-	relay	TP	-	test point
L	-	inductor	V	-	vacuum tube

6-4 ABBREVIATIONS

The following abbreviations are used in the "Description" column of the parts list:

AC	-	alternating current
AMP	-	ampere
ARM	-	armature
ASSY	-	assembly
BAT	-	battery
BLK	-	black
BLO	-	blower
BOT	-	bottom
BRKT	-	bracket
CAP	-	capacitor
CRT	-	cathode ray tube
CER	-	ceramic
COMP	-	composition
CONN	-	connector
DIA	-	diameter
DC	-	direct current
VDC	-	direct current volts
DIO	-	diode
DP	-	double pole
DPDT	-	double pole double throw
DPST	-	double pole single throw
DT	-	double throw

ELECT	-	electrolytic
FIG	-	figure
FIL H	-	fillister head
FXD	-	fixed
4P	-	four pole
GL	-	glass
GRN	-	green
GROM	-	grommet
H	-	henry
HEX	-	hexagon
IN	-	inches
K	-	kilohm
L	-	left
μF	-	microfarad
$\mu\mu$F	-	micromicrofarad
MTG	-	mounting
MEG	-	megohm
METFLM	-	metal film
METMY	-	metallic mylar
NHA	-	next higher assembly
NO	-	number
Ω	-	ohm
ORN	-	orange
POLY	-	polystyrene
POT	-	potentiometer
RES	-	resistor
SP	-	single pole
SPDT	-	single pole double throw
SPEC	-	specification
SPST	-	single pole single throw
SOT	-	value select on test
SEMICON	-	semiconductor
Si	-	Silicon
Ta	-	tantalum
TGL	-	toggle
V	-	volt
W	-	watts
WW	-	wirewound

6-5 MANUFACTURER

Following is the list of manufacturers which appear in the parts list. The Federal Supply Code is listed in numerical order and corresponding manufacturer's name and address is given.

01121 Allen Bradley Company
1201 South Second Street
Milwaukee, Wisconsin

04062 El Menco
Arco Electronics Inc.
Community Drive
Great Neck, New York

04713 Motorola Semiconductor Products Inc.
Box 955
Phoenix, Arizona

04941 Walsco Electronic Manufacturing Company
Radio & Electronic Division
Rockford, Illinois

06228 Texas Instrument Inc.
Box 5474
Dallas, Texas

06540 Amatom Electronic Hardware Company
432 Main Street
New Rochelle, New York

07115 Corning Glass Works
Electronic Products Division
3901 Electronics Drive
Raleigh, North Carolina

07263 Fairchild Semiconductor Corporation
313 Fairchild Drive
Mountain View, California

07999 Amphenol Corporation
Borg Instrument Division
Delavan, Wisconsin

08065 Accurate Rubber & Plastics Company
4370 Jutland Drive
San Diego, California

09023 Cornell-Dubilier Electronics
2653 Dalrymple
Sanford, North Carolina

09213 General Electric Company
Semiconductor Products
Dept. of Electronic Components
Buffalo, New York

11350 Penn Resistor Corporation
526 North Broad Street
Lansdale, Pennsylvania

12408 Elpac Inc.
4270 Artesia
Fullerton, California

13103 Thermolloy Company
4417 North Central Exp.
Dallas, Texas

21604 Buckeye Stamping Company
555 Marion Road
Columbus, Ohio

22229	Union Carbide Electronics 365 Middlefield Road Mountain View, California
28520	Heyman Manufacturing Company Michigan Avenue Kenilworth, New Jersey
37942	P. R. Mallory & Company 3029 East Washington Street Indianapolis, Indiana
49671	Radio Corporation of America Electronics Component Devices 415 South Fifth Street Harrison, New Jersey
49956	Raytheon Company Components Division 141 Spring Street Lexington, Massachusetts
56289	Sprague Electric Company 125 Marshall Street North Adams, Massachusetts
58474	Superior Electric Company 383 Middle Street North Adams, Massachusetts
71002	Birnbach Radio Company 435 Hudson Street New York, N. Y.
71450	CTS Corporation 1142 West Beardsley Avenue Elkhart, Indiana
71590	Centralab Division Glob Union Inc. Box 591 Milwaukee, Wisconsin
71700	Cornish Wire Company 730 Third Avenue New York, N. Y.
71785	Cinch Jones Manufacturing Company 1026 Homan Avenue Chicago, Illinois
73293	Hughes Aircraft Company Semiconductor Division 500 Superior Avenue Newport Beach, California
73899	JFD Electronics Corporation Components Division 15th Avenue at 62nd Street Brooklyn, New York
75042	International Resistance Company 414 North 13th Street Philadelphia, Pennsylvania
75915	Littelfuse Inc. 800 East Northwest Highway Des Plaines, Illinois
73487	James Millen Company Inc. 150 Exchange Street Malden, Massachusetts
77969	Rubbercraft Corporation of California Torrance, California
80294	Bourns Inc. Trimpot Division 1200 Columbia Avenue Riverside, California
80740	Beckman Instruments Inc. 2500 Harbor Boulevard Fullerton, California
83330	Herman H. Smith Inc. 812 Snediker Avenue Brooklyn, New York
84411	Good-All Manufacturing Company 112 West First Street Ogallala, Nebraska
86675	Pyramid Plastics Inc. 554 West Polk Street Chicago, Illinois
88245	USECO Division Litton Industries 13536 Salicoy Street Van Nuys, California
95397	Kemet Company 11901 Madison Avenue Cleveland, Ohio

6-6 ORDERING INFORMATION

When ordering spare or replacement parts address your order or inquiry either to a PSC sales representative nearest you or to:

CUSTOMER SERVICE
PRECISION STANDARDS CORP.
1701 REYNOLDS
SANTA ANA, CALIF. 92705

When ordering, always include the following information:

a. Model and serial number of instrument.
b. PSC part number.
c. Description.
d. If applicable, the reference designator.
e. If applicable, the next higher assembly.

6-7 PARTS LIST

The following lists all parts, less standard hardware. Parts that are subject to electrical or mechanical damage on an isolated or individual basis are listed. The listings provide ordering information for replacement parts and a means of component location through reference to an illustration.

The parts list uses a system of column indentation to show the relationship between the various items.

6-8 EFFECTIVITY CODE

This parts list covers serial numbers 9230051 and on.

All Serial Numbers	No Letter
9230051 thru 9230075	A
9230096 and on	B

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER					
			. Input Cable, red Spec. No. 98-28-129			98-28-129	1	
			. Input Cable, black Spec. No. 98-28-130			98-28-130	1	
			. Instrument Cover Assy			301-443-80	1	
			. . Cover			301-443-30	1	
			. . Handle Spec. No. 006-533-00			74-29-219	1	
			. . Support Cover			302-314-30	1	
			. Bottom Cover Assy			301-444-80	1	
			. . Bottom Cover			301-444-30	1	
			. . Rubber Feet	77969	4988	90-22-030	4	
			. Line Cord Bracket			301-445-30	1	
		J5, J10, J12	. Jack, black	71002	406 black	70-08-025	3	
		J6, J7, J8	. Jack, white	71002	406 white	70-08-027	3	
		J9, J11	. Jack, red	71002	406 red	70-08-028	2	
		T1	. Transformer Spec. No. 096-437-08			96-43-708	1	
			. Line Cord	71700	3598	98-28-103	1	
			. Line Cord Clamp	28520	SR-6P-1	74-11-075	1	
			. Support Bracket			301-305-31	1	
			. Chassis Bracket			301-318-30	1	
			. Back Panel			331-311-31	1	
			. Fuseholder	75915	342005	72-05-052	1	
		F1	. Fuse, 1/4 amp Slo-Blo	75915	313.250	72-02-015	1	
			. GPA-2 Bracket			331-317-30	1	
		TP1	. Standoff	88245	1417	73-77-210	1	
			. Grommet	08065	GB230-60	90-28-080	2	
			. Knob	21604	PS-70-2	77-02-015	2	
			. Knob	21604	PS-95DL-2	77-02-026	4	
			. Knob	21604	PS-125-2	77-02-035	6	
			. KVD Skirt, 0-9			301-436-30	4	
			. KVD Skirt, 0-10			301-437-30	2	
			. Panel Spacer	06540	8577A-0832	74-74-041	4	
			. Chassis			301-302-30	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. Front Panel Assy			331-312-82	1	
		DS1	. . Decimal Light Assy, No. 1			301-356-80	1	
		DS2	. . Decimal Light Assy, No. 2			301-358-80	1	
		DS3	. . Decimal Light Assy, No. 3			301-359-80	1	
		DS4	. . Decimal Light Assy, No. 4			301-367-80	1	
			. . Binding Post, red	58474	DF31RC	73-08-014	2	
			. . Binding Post, black	58474	DF31BC	73-08-013	3	
		C8	. . Cap. fxd. ceramic tubular .01μf 1000V	56289	10TMS10	45-04-105	1	
		M1	. . Meter Spec. No. 011-057-00			99-12-057	1	
		R12, R15	. . Res. Variable, 10K (Open & Short CKT Zero) Spec. No. 088-154-15			88-15-445	2	
		S4	. . Switch, SPDT			331-316-30	1	
			. . Front Panel			331-312-31	1	
		R123	. Res. fxd. comp. 100Ω ½W 5%	01121	EB1015	86-05-264	1	
		R124	. Res. fxd. comp. 100K ½W 5%	01121	EB1045	86-05-564	1	
		R125	. Res. fxd. comp. 270K ½W 5%	01121	EB2745	86-05-608	1	
		S1	. Switch, Rotary (Null) Spec. No. 095-806-61			95-80-661	1	
		S2	. Switch, Rotary (Range) Spec. No. 010-647-00			95-80-647	1	
		S3	. Switch, Rotary (Input Function) Spec. No. 010-646-00			95-80-646	1	

REFERENCES FIG	IND	SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. KVD Switch Assy, No. 1			331-104-82	1	
		R28 thru R39	. . Res. Set, WW 2K 3/4W .01%			14-36-022	1 set	
		R40	. . Res. fxd. WW 2.6Ω ½W 3%			14-19-021	1	
		R41	. . Res. Variable, 100Ω		Type 112	88-15-104	1	
		R42	. . Res. fxd. WW 4, 999Ω 3/4W .01%			14-36-029	1	
		S5	. . Switch Spec. No. 095-806-68			95-80-668	1	
			. KVD Switch Assy, No. 2			331-106-82	1	
		R43 thru R53	. . Res. Set, WW 2K 3/4W .02%			14-37-090	1 set	
		R54	. . Res. fxd. WW 5.5Ω ½W 10%			14-19-026	1	
		R55	. . Res. Variable, 100Ω	71450	Type 112	88-15-104	1	
		R56	. . Res. fxd. 4, 998Ω 3/4W .02%			14-36-090	1	
		S6	. . Switch Spec. No. 095-806-68			95-80-668	1	
			. KVD Switch Assy, No. 3			331-107-82	1	
		R57 thru R67	. . Res. Set, WW 2K ½W .03%			14-17-399	1 set	
		R68	. . Res. fxd. WW 9.5Ω ½W 10%			14-19-030	1	
		R69	. . Res. Variable, 100Ω	71450	Type 112	88-15-104	1	
		R70	. . Res. fxd. WW 4, 995.9Ω ½W .03%			14-17-405	1	
		S7	. . Switch Spec. No. 095-806-68			95-80-668	1	
			. KVD Switch Assy, No. 4			331-108-82	1	
		R71 thru R81	. . Res. Set, WW 2K ½W .05%			14-14-702	1 set	
		R82	. . Res. fxd. WW 13Ω ½W 5%			14-19-037	1	
		R83	. . Res. Variable, 100Ω	71450	Type 112	88-15-104	1	
		R84	. . Res. fxd. WW 4, 993Ω ½W .05%			14-14-705	1	
		S8	. . Switch Spec. No. 095-806-68			95-80-668	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (continued)					
			. KVD Switch Assy, No. 6			331-109-81	1	
		R85 thru R95	. . Res. Set, WW 2K $\frac{1}{2}$W .05%			14-14-702	1 set	
		R96	. . Res. fxd. comp. 20K $\frac{1}{4}$ W 5%	01121	CB2035	86-04-492	1	
		S9	. . Switch Spec. No. 095-806-68			95-80-668	1	
			. KVD Switch Assy, No. 7			331-117-80	1	
		R97 thru R106	. . Res. fxd. metal film 500Ω $\frac{1}{2}$W 1%	11350	FCA-15-500Ω	85-11-330	10	
		S10	. . Switch Spec. No. 010-643-00			95-80-643	1	

REFERENCES FIG	IND	SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. Calibration Board Assy			331-100-85	1	
		C3, C4	. . Cap. fxd. elect. 100-100μf	37942	SFO-121-162B	61-62-121	1	
		C6	. . Cap. fxd. poly. .47μf	12406	PD1A-474K	60-01-474	1	
		CR7, CR8	. . Semicon. Device, Diode Spec. No. 43235	-		94-43-235	2	
		CR9	. . Semicon. Device, Diode	04713	1N4750	92-47-500	1	
		R5	. . Res. fxd. comp. 100Ω ½W 5%	01121	EB1015	86-05-264	1	
		R6	. . Res. fxd. comp. 470Ω ½W 5%	01121	EB4715	86-05-332	1	
		R7	. . Res. fxd. comp. 390Ω ½W 5%	01121	EB3915	86-05-324	1	
		R23	. . Res. fxd. metal film 9 meg 1W 1%	75042	RN25X9004F	86-05-989	1	
		R24	. . Res. fxd. metal film 900K ½W 1%	11350	FCA-15-900K	85-11-953	1	
		R25	. . Res. fxd. metal film 90K ½W 1%	11350	FCA-15-90K	85-11-770	1	
		R26	. . Res. fxd. metal film 9K ½W 1%	11350	FCA-15-9K	85-11-580	1	
		R27	. . Res. fxd. metal film 900Ω ½W 1%	11350	FCA-15-900Ω	85-11-376	1	
		R107	. . Res. fxd. metal film 10 meg ½W 1%	11350	FCA-15-10 meg	85-11-989	1	
		R108	. . Res. fxd. metal film 10Ω ½W 1%	11350	FCA-15-10Ω	85-11-002	1	
		R109	. . Res. fxd. metal film 90Ω ½W 1%	11350	FCA-15-90Ω	85-11-185	1	
		R110	. . Res. Variable 500Ω 1½W 20% (100V Cal)	71450	Type 110	88-15-208	1	
		R111, R113, R129 thru R132	. . Resistor Set, WW (1) 1.1053 meg (1) 94.025K, (4) 2.487 meg 1W .01%	-		14-46-900	1 set	
		R112	. . Res. fxd. WW 7K ¼W .05%	-		15-15-435	1	
		R114	. . Res. Variable, 10K 1½W 10% (1000V Cal)	71450	Type 110	88-15-421	1	
		R115	. . Res. fxd. metal film 82K ½W 1%	11350	FCA-15-82K	85-11-764	1	
		R116	. . Res. fxd. WW 19.795K 3/4W .01%	-		14-36-105	1	
		R117	. . Res. Variable 10Ω 1½W 20% (1V Cal)	71450	Type 110	88-15-065	1	
		R133	. . Res. fxd. WW 2.4444 3/4W .01%			14-36-023	1	
		R134	. . Res. fxd. metal film 1K ½W 1%	11350	FCA-15-1K	85-11-400	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. AC Converter Board Assy			331-121-81	1	
			. . Mounting Bracket	49956	MB-125	74-08-102	2	
			. . Switch Coupling	76487	39001	74-40-005	1	
			. . Standoff, hex. 6-32 x $\frac{1}{2}$	06540	9739-B-0632	74-73-109	2	
			. . Standoff, hex. 6-32 x 7/8	06540	9742-B-0632	74-73-209	3	
			. . Spacer, 6-32 x $\frac{1}{2}$	83330	2102	74-73-102	2	
			. . Shield, 1 Volt Converter			331-125-31	1	
			. . Shield, Switch Divider			331-309-30	1	
		C22	. . Cap. fxd. metmy. .01μf 200V	12406	ZX2A-103K	55-00-103	1	
		R141	. . Res. fxd. comp. 1K $\frac{1}{2}$W 5%	01121	EB1025	86-05-364	1	
			. Switch Divider Calibration Assy			331-122-80	1	
			. . Mounting Bracket			331-123-30	1	
			. . Grommet	04941	7034	90-28-024	1	
			. . Spacer, 6-32 x $1\frac{1}{2}$	83330	8509	74-73-105	3	
			. . Detent Adj.			331-319-30	1	
			. . Switch Shield Spec. No. 010-628-00			95-80-602	1	
		S2F, S2G	. . Switch, Wafer	71450	212-112A	95-80-677	2	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. Input Attenuator Board Assy			331-120-82	1	
		C9, C12	. . Cap. fxd. durmica 2$\mu\mu$f 500V	04062	DM-15-020K	53-00-020	2	
		C10, C13, C17	. . Cap. Variable . 8-8. 5$\mu\mu$f	73899	VC-9GW	65-00-005	3	
		C11	. . Cap. fxd. durmica 2000$\mu\mu$f 500V	04062	DM-19-202J	53-09-202	1	
		C14	. . Cap. Variable 3. 3-5$\mu\mu$f 600V	71590	TCN3R3	48-13-330	1	
		C15	. . Cap. fxd. durmica 5$\mu\mu$f 500V	04062	DM-15-050K	53-00-050	1	
		C16	. . Cap. fxd. durmica 10$\mu\mu$f 500V	04062	DM-15-100K	53-00-100	1	
		C18	. . Cap. fxd. durmica 120$\mu\mu$f 500V	04062	DM-10-121J	53-02-121	1	
		R118	. . Res. Variable, 5K	80740	78PR5K	88-20-741	1	
		R119, R136	. . Res. fxd. metal film 1. 96K $\frac{1}{2}$W 1%	75042	RN60E1961F	83-07-389	2	
		R120	. . Res. fxd. metal film 121K $\frac{1}{2}$W 1%	75042	RN60E1213F	83-07-781	1	
		R121	. . Res. Variable, 500Ω	80740	78PR500	88-20-486	1	
		R122	. . Res. fxd. metal film 10K $\frac{1}{2}$W 1%	75042	RN60E1002F	83-07-533	1	
		R126, R127, R128, R137	. . Res. fxd. metal film 1 meg $\frac{1}{2}$W 1%	75042	RN60E1004F	83-44-961	4	
		R135	. . Res. Variable, 100Ω	80740	78PR100	88-20-321	1	
		C20, C21	. . SOT					
		R138, R139, R140	. . SOT					

REFERENCES FIG	IND	SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. "1" Volt Converter Board Assy			331-119-83	1	
		C401, C411, C412	. . Cap. fxd. met. poly. .47μf 400V	12406	B4A-474K	60-07-474	3	
		C402	. . Cap. fxd. durmica 2μμf 500V	04062	DM-15-020K	53-00-020	1	
		C403	. . Cap. fxd. metmy. 2μf 200V	12406	ZX2A-205K	55-00-205	1	
		C404	. . Cap. fxd. ta. 60μf 6V	84411	Type 901	64-21-606	1	
		C405	. . Cap. fxd. durmica 100μμf 500V	04062	DM-15-101K	53-00-101	1	
		C406	. . Cap. fxd. durmica 20μμf 500V	04062	DM-15-200K	53-00-200	1	
		C407	. . Cap. fxd. elect. 100μf 25V	56289	30D188A1	61-04-107	1	
		C408	. . Cap. Assy, 5μf 200V	00116		301-468-80	1	
		C414	. . Cap. Variable, .8-8.5μμf	73899	VC-9GW	65-00-005	1	
		CR401, CR402	. . Semicon. Device, Diode Spec. No. 094-456-00			94-45-600	2	
		CR408	. . Semicon Device, Diode Spec. No. 001-581-00			94-45-581	1	
		Q402	. . Transistor, Si. NPN	09213	2N3391	91-33-910	1	
		Q403, Q404, Q405	. . Transistor Spec. No. 001-515-00			94-60-200	3	
		R401, R425	. . Res. fxd. metal film 1 meg ½W 1%	75042	RN70C1004F	83-44-961	2	
		R402	. . Res. fxd. metal film 50K ½W 1%	11350	FCA-15-50K	85-11-725	1	
		R403	. . Res. fxd. metal film 60.4K ½W 1%	11350	FCA-15-60.4K	85-11-730	1	
		R404	. . Res. fxd. comp. 2.2K ½W 5%	01121	EB2225	86-05-396	1	
		R405	. . Res. fxd. comp. 150K ½W 5%	01121	EB1545	86-05-580	1	
		R406	. . Res. fxd. comp. 15K ½W 5%	01121	EB1535	86-05-480	1	
		R407, R412	. . Res. fxd. comp. 680Ω ½W 5%	01121	EB6815	86-05-348	2	
		R408, R417	. . Res. fxd. metal film 150K ½W 1%	11350	FCA-15-150K	85-11-814	2	
		R409	. . Res. fxd. comp. 1.8K ½W 5%	01121	EB1825	86-05-388	1	
		R410	. . Res. fxd. comp. 270Ω ½W 5%	01121	EB2715	86-05-308	1	
		R411	. . Res. fxd. comp. 180K ½W 5%	01121	EB1845	86-05-588	1	
		R413	. . Res. fxd. comp. 3.9K ½W 5%	01121	EB3925	86-05-424	1	
		R414	. . Res. fxd. comp. 270K ½W 5%	01121	EB2745	86-05-608	1	
		R415	. . Res. fxd. comp. 20K ½W 5%	01121	EB2035	86-05-492	1	
		R416	. . Res. fxd. metal film 300K ½W 1%	11350	FCA-15-300K	85-11-870	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. "1" Volt Converter Board Assy (Continued)			331-119-83	1	
		R419	. . Res. fxd. WW 22.1K $\frac{1}{2}$W .25%			16-43-520	1	
		R423	. . Res. fxd. WW 1K $\frac{1}{4}$W .1%			15-14-290	1	
		R424	. . Res. Variable, 10Ω	71450	Type 110	88-15-065	1	
		V401	. . Nuvistor	49671	6CW4	97-02-125	1	
			. . Socket	71785	5NS-2	73-75-256	1	
			. Schematic			331-121-(83)		
			. Power Supply Board Assy			331-124-80	1	
			. . Heatsink	13103	2211B	74-12-116	1	
			. . Cap. fxd. elect. 500μf 25V	09023	BR-2500-25V	61-80-510	1	
		C415, C416	. . Cap. fxd. metmy. 1μf 200V	12406	ZX2A-105K	55-00-105	2	
		C417, C418	. . Cap. fxd. elect. 50μf 150V	86675	TD-50-150	61-70-506	2	
		CR403	. . Semicon. Device, Diode	12060	SD-6	94-02-006	1	
		CR404 thru CR407	. . Semicon. Device, Diode	12060	DI-1261	94-02-600	4	
		Q406, Q410, Q419	. . Transistor, Si. PNP	07263	2N3638	91-36-380	3	
		Q407, Q408, Q413	. . Transistor, Si. NPN	09213	2N3391	91-33-910	3	
		Q411, Q412, Q414	. . Transistor Spec. No. 001-535-00			94-63-535	3	
		R424	. . Res. fxd. metal film 90K$\frac{1}{2}$W 1%	11350	FCA-15-90K	85-11-770	1	
		R426	. . Res. fxd. metal film 6K $\frac{1}{2}$W 1%	11350	FCA-15-6K	85-11-560	1	
		R427	. . Res. Variable, 1K	71450	Type 110	88-15-256	1	
		R429	. . Res. fxd. comp. 43K $\frac{1}{2}$W 5%	01121	EB4335	86-05-528	1	
		R430	. . Res. fxd. comp. 180Ω $\frac{1}{2}$W 5%	01121	EB1815	86-05-288	1	
		R431	. . Res. fxd. comp. 2.7K $\frac{1}{2}$W 5%	01121	EB2725	86-05-408	1	
		R432	. . Res. fxd. comp. 30K $\frac{1}{2}$W 5%	01121	EB3035	86-05-512	1	
		R433	. . Res. fxd. comp. 10 meg $\frac{1}{2}$W 5%	01121	EB1065	86-05-764	1	
		R434	. . Res. fxd. comp. 3.9K $\frac{1}{2}$W 5%	01121	EB3925	86-05-424	1	
		R435, R436	. . Res. fxd. comp. 10K $\frac{1}{2}$W 5%	01121	EB1035	86-05-464	2	
		R437	. . Res. fxd. comp. 470Ω 1W 5%	01121	GB4715	86-06-332	1	
		R438	. . Res. fxd. comp. 33Ω 1W 5%	01121	GB3305	86-06-216	1	
			. Schematic			331-124-(80)		

REFERENCES FIG	IND	SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. Reference & Amplifier Mother Board Assy			331-118-85	1	
			. . Connector, 12 pin	71785	257-1-2-12-0-3-2	70-20-221	1	
		C1, C2	. . Cap. fxd. elect. 100μf 25V	56289	30D188A1	61-04-107	2	
		C5	. . Cap. Assy, 2μf 200V			301-467-80	1	
		C7	. . Cap. Assy, 1μf 200V			301-466-80	1	
		CR1 thru CR4	. . Semicon. Device, Diode Spec. No. 43224			94-43-224	4	
		R8	. . Res. fxd. metal film 7.4K ½W 1%	11350	FCA-15-7.4K	85-11-563	1	
		R9	. . Res. Variable 2K 1½W 20% (Meter Cal)	71450	Type 110	88-15-271	1	
		R10, R11	. . Res. fxd. comp. 33K ½W 5%	01121	EB3335	86-05-516	2	
		R13, R14	. . Res. fxd. comp. 2.7K ½W 5%	01121	EB2725	86-05-408	2	
		R16	. . Res. fxd. comp. 3.3K ½W 5%	01121	EB3325	86-05-416	1	
		R17	. . Res. fxd. metal film 10Ω ½W 1%	11350	FCA-15-10Ω	85-11-002	1	
		R18	. . Res. fxd. metal film 1 meg ½W 1%	75042	RN70C1004F	83-44-961	1	
		R19, R21	. . Res. fxd. metal film 100K ½W 1%	11350	FCA-15-100K	85-11-779	2	
		R20	. . Res. fxd. metal film 90Ω ½W 1%	11350	FCA-15-90Ω	85-11-185	1	
		R22	. . Res. fxd. metal film 1.5 meg ½W 1%	75042	RN70D1504F	83-46-961	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. GPA-2 Amplifier Board Assy			501-101-83	1	A
			. . Top Cover			501-301-32	1	
			. . Bottom Cover			501-302-32	1	
		C1, C2	. . Cap. fxd. metmy. .001μf 200V	12406	ZX2A-102K	55-00-102	2	
		C2, C4	. . Cap. fxd. select on test 5 to 15μμf 600V ceramic			299-000-36	1	
		C5	. . Cap. fxd. durmica 1μμf 500V	04062	DM-10-010	53-02-010	1	
		C6	. . Cap. Variable, 8-4.5μμf (Voltage Adjust #1)	73899	VC-10GW	65-00-010	1	
		C7	. . Cap. fxd. glass 47μμf 300V	07115	TY-06-470J	51-19-470	1	
		C8	. . Cap. Variable, 8-8.5μμf (Current Adjust)	73899	VC-9GW	65-00-005	1	
		C9	. . Cap. fxd. met. polycarbonate .01μf 200V	12406	B2A-103J	60-03-103	1	
		C10	. . Cap. fxd. tantalum 3.3μf 15V	95397	K3R3C15K	64-24-335	1	
		C11	. . Cap. fxd. metmy. .039μf 200V	12406	ZX2A-393K	55-00-393	1	
		C12	. . Cap. fxd. met. polycarbonate .047μf 100V	12406	B1A-473J	60-05-473	1	
		C13	. . Cap. fxd. ceramic 1000μμf 1KV	71590	DD-102	48-10-102	1	
		C14	. . Cap. fxd. cer. 20μμf 1KV	71590	DD-200	48-10-200	1	
		C15, C17	. . Cap. fxd. cer. .002μf 1KV	71590	Type CG	48-10-202	2	
		C16, C18	. . Cap. fxd. cer. .005μf 50V	56289	40C172A5	45-05-501	2	
		C19	. . Cap. fxd. cer. .0022μf 1 KV	71590	DD-222	48-10-222	1	
		CR1 thru CR9	. . Semicon. Device, Diode Spec. No. 001-581-00			94-45-581	9	
		Q1, Q2, Q6, Q7, Q10, Q11, Q13, Q14, Q15, Q16, Q19	. . Transistor, Si. NPN	09213	2N3391	91-33-910	11	
		Q3	. . Transistor, Si. NPN	09213	2N2714	91-27-140	1	
		Q4, Q20	. . Transistor	22229	UC734	94-60-229	2	
		Q5	. . Transistor, Si. NPN	09213	2N3390	91-33-900	1	
		Q8, Q9	. . Transistor Matched Set Spec. No. 011-021-001			94-58-601	1 set	
		Q12	. . Transistor, Si. PNP	07263	2N3640	91-36-400	1	
		Q17, Q18	. . Transistor, Si. PNP	07263	2N3638	91-36-380	2	
		R1, R48	. . Res. fxd. comp. 13K $\frac{1}{4}$ W 5%	01121	CB1335	86-04-476	2	
		R3, R7	. . Res. fxd. comp. 68K $\frac{1}{4}$ W 5%	01121	CB6835	86-04-548	2	
		R4, R6	. . Res. fxd. comp. 680K $\frac{1}{4}$ W 5%	01121	CB6845	86-04-648	2	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	HONEYWELL PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. GPA-2 Amplifier Board Assy (Continued)					
		R5, R11	. . Res. fxd. comp. 18K $\frac{1}{4}$W 5%	01121	CB1835	86-04-488	2	
		R9	. . Res. fxd. comp. 100K $\frac{1}{4}$W 5%	01121	CB1045	86-04-564	1	
		R10	. . Res. fxd. comp. 27K $\frac{1}{4}$W 5%	01121	CB2735	86-04-508	1	
		R12	. . Res. fxd. comp. 330K $\frac{1}{4}$W 5%	01121	CB3345	86-04-616	1	
		R13, R29	. . Res. fxd. comp. 10 meg. $\frac{1}{4}$W 5%	01121	CB1065	86-04-764	2	
		R14, R40	. . Res. fxd. comp. 560K $\frac{1}{4}$W 5%	01121	CB5645	86-04-640	2	
		R15	. . Res. fxd. comp. 56K $\frac{1}{4}$W 5%	01121	CB5635	86-04-540	1	
		R16	. . Res. fxd. comp. 12K $\frac{1}{4}$W 5%	01121	CB1235	86-04-472	1	
		R17	. . Res. fxd. comp. 3.3Ω $\frac{1}{2}$W 5%	01121	EB33G5	86-05-116	1	
		R18	. . Res. fxd. comp. 91K $\frac{1}{4}$W 5%	01121	CB9135	86-04-560	1	
		R19, R23	. . Res. fxd. comp. 270K $\frac{1}{4}$W 5%	01121	CB2745	86-04-608	2	
		R20, R32	. . Res. fxd. comp. 220K $\frac{1}{4}$W 5%	01121	CB2245	86-04-596	2	
		R21	. . Res. fxd. comp. 22 meg. $\frac{1}{4}$W 5%	01121	CB2265	86-04-796	1	
		R22	. . Res. fxd. comp. 1K $\frac{1}{4}$W 5%	01121	CB1025	86-04-364	1	
		R24, R33, R35	. . Res. fxd. comp. 82K $\frac{1}{4}$W 5%	01121	CB8235	86-04-556	3	
		R25	. . Res. fxd. comp. 75K $\frac{1}{4}$W 5%	01121	CB7535	86-04-552	1	
		R27	. . Res. fxd. comp. 470Ω $\frac{1}{4}$W 5%	01121	CB4715	86-04-332	1	
		R28	. . Res. fxd. comp. 5.1K $\frac{1}{4}$W 5%	01121	CB5125	86-04-436	1	
		R30	. . Res. fxd. comp. 100 meg $\frac{1}{4}$W 5%	01121	CB1075	86-04-864	1	
		R31	. . Res. fxd. comp. 1 meg $\frac{1}{4}$W 5%	01121	CB1055	86-04-664	1	
		R34	. . Res. Variable 10K 1W 10% (Voltage Adjust #2)	96971	2600P	88-05-353	1	
		R36, R37	. . Res. fxd. comp. 2.7K $\frac{1}{4}$W 5%	01121	CB2725	86-04-408	2	
		R38	. . Res. fxd. comp. 100Ω $\frac{1}{4}$W 5%	01121	CB1015	86-04-264	1	
		R39	. . Res. fxd. comp. 10K $\frac{1}{4}$W 5%	01121	CB1035	86-04-464	1	
		R41	. . Res. fxd. comp. 6.2K $\frac{1}{4}$W 5%	01121	CB6225	86-04-444	1	
		R42	. . Res. fxd. comp. 7.5K $\frac{1}{4}$W 5%	01121	CB7525	86-04-452	1	
		R43	. . Res. fxd. comp. 6.8K $\frac{1}{4}$W 5%	01121	CB6825	86-04-448	1	
		R44	. . Res. fxd. comp. 620Ω $\frac{1}{4}$W 5%	01121	CB6215	86-04-344	1	
		R45	. . Res. fxd. comp. 47K $\frac{1}{4}$W 5%	01121	CB4735	86-04-532	1	
		R46	. . Res. fxd. comp. 220Ω $\frac{1}{4}$W 5%	01121	CB2215	86-04-296	1	
		R47	. . Res. fxd. comp. 3.9 meg. $\frac{1}{4}$W 5%	01121	CB3955	86-04-725	1	
			. Schematic			501-101-(81)		

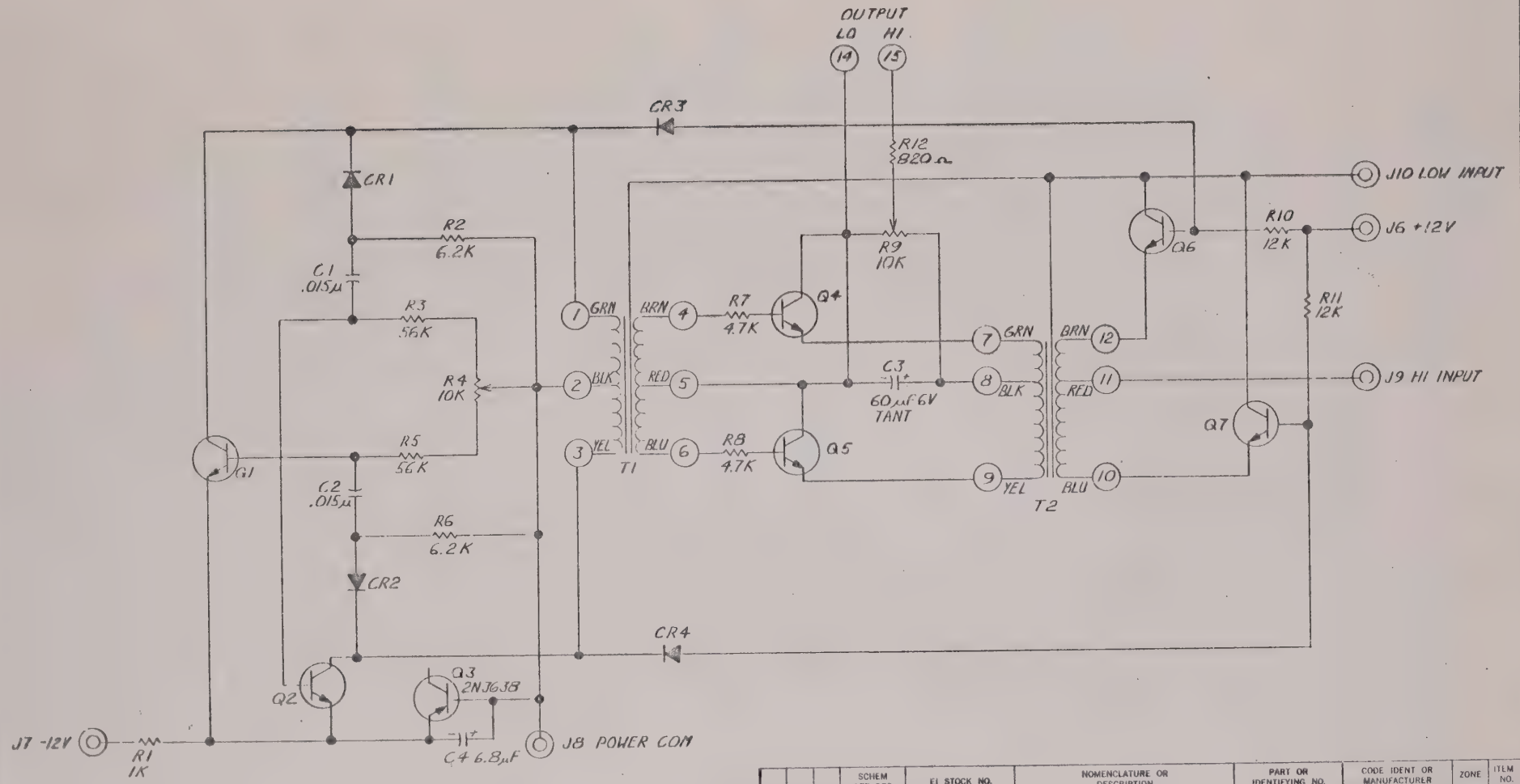
REFERENCES FIG	IND	SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	PART NO.	ONE PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. GPA-2 Amplifier Board Assy			501-105-80	1	B
			. . Top Cover			501-303-30	1	
			. . Bottom Cover			501-302-32	1	
		1C1	. . Integrated Circuit, linear amp.	07263	UA709	94-90-210	1	
		C1, C4	. . Cap. fxd. durmica 10μμf 500V	04062	DM-15-100J	53-01-100	2	
		C2, C5	. . Cap. fxd. ceramic 3μμf 600V	71590	TCZ-3R3	48-14-033	2	
		C3, C6, C7, C16	. . Cap. fxd. ceramic 200μμf 1KV	71590	DD-201	48-10-201	4	
		C8	. . value select on test					
		C9	. . Cap. fxd. metmy. .0022μf 200V	12406	ZX2A-222K	55-00-222	1	
		C10, C14, C15 C17	. . Cap. fxd. cer. .01μf 50V	56289	19C214A6	45-05-112	4	
		C11	. . Cap. fxd. metmy. .039μf 200V	12406	ZX2A-393K	55-00-393	1	
		C12	. . Cap. fxd. met. polycarbonate .047μf 100V	12406	B1A-473J	60-05-473	1	
		C13	. . Cap. fxd. cer. .005μf 50V	56289	40C172A5	45-05-501	1	
		C18	. . Cap. Variable 8-8.5μμf (Voltage Adjust #1)	73899	VC-9GW	65-00-005	1	
		C19	. . Cap. fxd. glass 47μμf 300V	07115	TY-06-470J	51-19-470	1	
		C20	. . Cap. Variable 8-4.5μμf (Current Adjust)	73899	VC-10GW	65-00-010	1	
		C21, C22	. . Cap. fxd. durmica 1μμf 500V	04062	DM-10-010	53-02-010	2	
		C23	. . Cap. fxd. met. polycarbonate .01μf 200V	12406	B2A-103J	60-03-103	1	
		C24, C26, C27 C30, C31	. . Cap. fxd. tantalum 3.3μf 15V	95397	K3R3C15K	64-24-335	5	
		C25, C32, C33	. . Cap. fxd. cer. .0022μf 1KV	71590	DD-222	48-10-222	3	
		C28, C29	. . Cap. fxd. cer. 470μμf 1KV	71590	DD-471	48-10-473	2	
		C34	. . value select on test					
		CR1, CR2	. . Semicon. Device, Diode	06228	1N916	92-09-160	2	
		CR3 thru CR7	. . Semicon. Device, Diode Spec. No. 001-581-00	00116		94-45-581	5	
		Q1, Q3, Q5	. . Transistor, Si. NPN	07263	2N3646	91-36-460	3	
		Q2, Q4, Q16	. . Transistor, Si. PNP	07263	2N4916	91-49-160	3	
		Q6	. . Transistor, Unijunction	04713	2N4852	91-48-520	1	
		Q7	. . Transistor, Si. NPN	09213	2N2714	91-27-140	1	
		Q9, Q10	. . Transistor	22229	UC734	94-60-229	2	
		Q11	. . Transistor, Si. NPN	09213	2N3390	91-33-900	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. GPA-2 Amplifier Board Assy (Continued)					
		Q12 thru Q15	. . Transistor, Si. NPN	09213	2N3391	91-33-910	4	
		Q17, Q18	. . Transistor, Si. PNP	07263	2N4249	91-42-490	2	
		R1, R6, R10, R46, R47	. . Res. fxd. comp. 10K $\frac{1}{4}$W 5%	01121	CB1035	86-04-464	5	
		R2, R11	. . Res. fxd. comp. 13K $\frac{1}{4}$W 5%	01121	CB1335	86-04-476	2	
		R3, R8	. . Res. fxd. comp. 39K $\frac{1}{4}$W 5%	01121	CB3935	86-04-524	2	
		R4, R9, R18	. . Res. fxd. comp. 100K $\frac{1}{4}$W 5%	01121	CB1045	86-04-564	3	
		R5, R7	. . Res. fxd. comp. 18K $\frac{1}{4}$W 5%	01121	CB1835	86-04-488	2	
		R12	. . Res. fxd. comp. 100Ω $\frac{1}{4}$W 5%	01121	CB1015	86-04-264	1	
		R13, R17	. . Res. fxd. comp. 470K $\frac{1}{4}$W 5%	01121	CB4745	86-04-632	2	
		R14	. . Res. fxd. comp. 360K $\frac{1}{4}$W 5%	01121	CB3645	86-04-620	1	
		R15	. . Res. fxd. comp. 330K $\frac{1}{4}$W 5%	01121	CB3345	86-04-616	1	
		R16, R29	. . Res. fxd. comp. 10 meg $\frac{1}{4}$W 5%	01121	CB1065	86-04-764	2	
		R19	. . Res. fxd. comp. 3.9 meg $\frac{1}{4}$W 5%	01121	CB3955	86-04-725	1	
		R20, R39	. . Res. fxd. comp. 56K $\frac{1}{4}$W 5%	01121	CB5635	86-04-540	2	
		R21	. . Res. fxd. comp. 3.3Ω $\frac{1}{4}$W 5%	01121	EB33G5	86-05-116	1	
		R22, R45	. . Res. fxd. comp. 12K $\frac{1}{4}$W 5%	01121	CB1235	86-04-472	2	
		R23	. . Res. fxd. comp. 4.7K $\frac{1}{4}$W 5%	01121	CB4725	86-04-432	1	
		R24	. . Res. fxd. comp. 91K $\frac{1}{4}$W 5%	01121	CB9135	86-04-560	1	
		R26	. . Res. fxd. comp. 1.5K $\frac{1}{4}$W 5%	01121	CB1525	86-04-380	1	
		R27	. . Res. fxd. comp. 130K $\frac{1}{4}$W 5%	01121	CB1345	86-04-576	1	
		R28	. . Res. fxd. comp. 470Ω $\frac{1}{4}$W 5%	01121	CB4715	86-04-332	1	
		R30, R43, R44	. . Res. fxd. comp. 1 meg $\frac{1}{4}$W 5%	01121	CB1055	86-04-664	3	
		R31	. . Res. fxd. comp. 220K $\frac{1}{4}$W 5%	01121	CB2245	86-04-596	1	
		R32	. . Res. fxd. comp. 100 meg $\frac{1}{4}$W 5%	01121	CB1075	86-04-864	1	
		R33	. . Res. Variable 10K 1W 10% (Voltage Adjust #2)	96971	2600P	88-05-353	1	
		R34, R37	. . Res. fxd. comp. 82K $\frac{1}{4}$W 5%	01121	CB8235	86-04-556	2	
		R35, R36	. . Res. fxd. comp. 2.7K $\frac{1}{4}$W 5%	01121	CB2725	86-04-408	2	
		R38	. . Res. fxd. comp. 47K $\frac{1}{4}$W 5%	01121	CB4735	86-04-532	1	
		R40	. . Res. fxd. comp. 1.2K $\frac{1}{4}$W 5%	01121	CB1225	86-04-372	1	
		R41	. . Res. fxd. comp. 6.2K $\frac{1}{4}$W 5%	01121	CB6225	86-04-444	1	
		R42	. . Res. fxd. comp. 62K $\frac{1}{4}$W 5%	01121	CB6235	86-04-544	1	
			. Schematic	-		501-105-(80)		

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
		.	. Reference Supply Board Assy			331-103-81	1	
		C1	. . Cap. fxd. cer. 560$\mu\mu$f 1000V	71590	DD-561	48-10-561	1	
		C2	. . Cap. fxd. cer. 220$\mu\mu$f 1000V	71590	DD-221	48-10-221	1	
		CR1	. . Semicon. Device, Diode	04713	1N821	92-08-210	1	
		CR2, CR3, CR4	. . Semicon. Device, Diode Spec. No. 001-581-00			94-45-581	3	
		CR5, CR6	. . Semicon. Device, Diode	73293	1N456	92-04-560	2	
		CR7	. . Semicon. Device, Diode Spec. No. 43273			94-43-273	1	
		Q1, Q3, Q4	. . Transistor, Si. NPN	09213	2N3391	91-33-910	3	
		Q2	. . Transistor, Si. PNP	07263	2N3638	91-36-380	1	
		Q5	. . Transistor Spec. No. 001-514-00			94-60-240	1	
		R1	. . Res. fxd. comp. 2K $\frac{1}{4}$W 5%	01121	CB2025	86-04-392	1	
		R2	. . Res. fxd. comp. 12 meg $\frac{1}{2}$W 5%	01121	EB1265	86-05-772	1	
		R3	. . Res. fxd. comp. 150Ω $\frac{1}{4}$W 5%	01121	CB1515	86-04-280	1	
		R4	. . Res. fxd. metal film 22.1K 1/8W 1%	75042	RN60E2212F	83-07-555	1	
		R5	. . Res. fxd. comp. 1K $\frac{1}{4}$W 5%	01121	CB1025	86-04-364	1	
		R6	. . Res. fxd. comp. 220K $\frac{1}{4}$W 5%	01121	CB2245	86-04-596	1	
		R7, R11, R17	. . Res. fxd. comp. 220Ω $\frac{1}{4}$W 5%	01121	CB2215	86-04-296	3	
		R8	. . Res. fxd. comp. 2.7K $\frac{1}{4}$W 5%	01121	CB2725	86-04-408	1	
		R9	. . Res. fxd. metal film 10K 1/8W 1%	75042	RN60E1002F	83-07-533	1	
		R10	. . Res. fxd. metal film 2.37K 1/8W 1%	75042	RN60E2371F	83-07-490	1	
		R12, R13	. . select on test					
		R14	. . Res. fxd. metal film 12.4K 1/8W 1%	75042	RN60E1242F	83-07-536	1	
		R15	. . Res. fxd. metal film 8.5K 1/8W 1%	75042	RN60E8501F	83-07-532	1	
		R16	. . Res. Variable 100Ω (T.C. ADJ)	80294	3067P-1-101	88-20-306	1	
		R18	. . Res. fxd. metal film 2.74K 1/8W 1%	75042	RN60E2741F	83-07-499	1	
		R19, R20	. . select on test					
		R21	. . Res. fxd. WW 640Ω $\frac{1}{4}$W .5%			12-12-300	1	
		R22	. . Res. fxd. WW 4.3 to 5.3K $\frac{1}{4}$W .05%			299-000-17	1	

REFERENCES FIG	REFERENCES IND	REFERENCES SCHEM OR ITEM	DESCRIPTION 1 2 3 4 5 6 7	MANUFACTURER'S CODE	MANUFACTURER'S PART NO.	PART NO.	QTY/ ASSY	EFF. CODE
			MODEL 1002 AC DIFFERENTIAL VOLTMETER (Continued)					
			. Reference Supply Board Assy (Continued)					
		R23	. . Res. fxd. WW 10Ω to 90Ω $\frac{1}{4}$W 1%	00116		299-000-15	1	
		R24	. . Res. fxd. WW 6.2K $\frac{1}{4}$W .05%	00116		12-15-621	1	
		R25	. . Res. fxd. metal film 1.27 meg $\frac{1}{2}$W 1%	75042	RN70E1274F	83-58-900	1	
		R26	. . Res. Variable 10K (CAL)	80740	75PR10K	88-20-829	1	
			. Schematic	00116		331-103-(80)		

DASH	SYM	ZONE	DESCRIPTION	DATE	APPROVED
(80)	A		C4 WAS NOT SHOWN	7-1566	JS
(80)	B		ROTATED CR-9 EGR-3 180°	12-12	JS



NOTES:
1. ALL DIODES ARE EI 581.
2. TRANSISTORS ARE 2N2714 UNLESS OTHERWISE NOTED.
3. ALL RESISTORS ARE 1/4W, 5% CARBON UNLESS OTHERWISE NOTED.
4. POTS. ARE CTS. 110 TYPE.

BOARD # 331-116

NEXT ASSY	USED ON
APPLICATION	

QTY REQD PER DASH NO	SCHEM REF DES	EI STOCK NO.	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.	CODE IDENT OR MANUFACTURER	ZONE	ITEM NO.
LIST OF MATERIALS OR PARTS LIST							

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/32 DECIMALS ± .010 ANGLES ± 1/2°
MATERIAL
FINISH

DRAWN JIM SCHEIDLE 9-8-66
CHECKED
APPROVED
RELEASED
DESIGN ACTIVITY APPROVAL

TITLE RECORDER ISOLATION AMP. (SCHEMATIC)

CODE IDENT NO.	SIZE	DRAWING NO.	REV
	C	331-307-(80)	B

SCALE NONE | WEIGHT | SHEET 1 OF 1

08-304-075

PRECISION Standards CORP.
P.O. BOX 8361 SAN MARINO, CALIF.

SECTION VI

WARRANTY

The PRECISION STANDARDS CORPORATION warrants each instrument to be free from defects in material and workmanship. The instrument must be returned to the factory with shipping prepaid and a complete report of the difficulty. This warranty is good for one year from the shipping date.

SHIPPING DAMAGE

If there is any damage to the instrument upon receipt, report this to the transportation claim agent immediately.

MP MASTER
MA35183